DOCUMENT RESUME

ED 236 042 SE 043 383

AUTHOR	Fraser, Barry J.; Northfield, Jeffrey R.
TITLE	A Study of Some Aspects of ASEP during Its First Year of Availability. CDC Professional Series.
INSTITUTION	Curriculum Development Centre, Canberra (Australia).
REPORT NO	ISBN-0-642-96073-9
PUB DATE	May 81
NOTE	87p.; Portions of the appendices will reproduce marginally because of small print.
AVAILABLE FROM	Curriculum Development Centre, P.O. Box 52, Dickson, A.C.T. 2602 Canberra, Australia ($5.60 in Australian currency).
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	*Academic Achievement; *Classroom Environment; Critical Thinking; *Curriculum Development; Curriculum Evaluation; Grade 7; Inquiry; Science Course Improvement Projects; Science Curriculum; Science Education; *Science Instruction; Secondary Education; *Secondary School Science; Skill Development; *Student Attitudes
IDENTIFIERS	Australia; *Australian Science Education Project; Science Education Research

ABSTRACT

During 1974, materials developed by the Australian Science Education Projects (ASEP) became available in final published form. The publication of these materials was an especially important undertaking since ASEP was the first national curriculum project, in any subject area, to be developed in Australia. This report presents research into four aspects of ASEP evaluation. All studies were conducted at the seventh grade level and involved students in Victoria high schools. Questionnaires were used in the first study (chapter 2) to investigate teachers' understanding of ASEP philosophy and the impact of ASEP materials on their ideas about science teaching. In the second study (chapter 3), a battery of learning outcome measures were administered to ASEP/non-ASEP students at the beginning and end of the school year to examine the effectiveness of ASEP/non-ASEP materials in promoting learning changes. The impact of the learning environment as a focus for curriculum evaluation and research related to the learning environment in ASEP classrooms was investigated in the third study (chapter 4). The fourth study (chapter 5) made a comparison between classroom climate perceptions of ASEP/non-ASEP students and looked at the relationship between those perceptions and student learning. Objectives, methodology, results, and conclusions are provided for each of the studies. (Background information, origin/nature of ASEP, contemporary scene in science education, and first/second generation curriculum projects are discussed in the introductory section of the report. Appendixes present results of two 1974 surveys of science teachers' knowledge and use of ASEP, sample items from scales measuring learning outcomes, and examples of student activity charts.) (JN)

CDC PROFESSIONAL SERIES

SE

ED236042

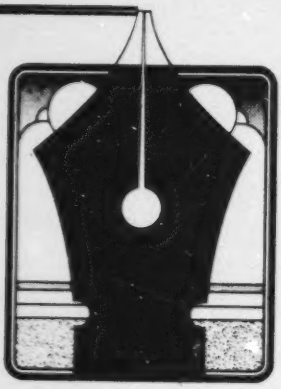
A Study of Some Aspects of ASEP During its First Year of Availability

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.



"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Curriculum Development Center
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Barry J. Fraser
Jeffrey R. Northfield

SE043383

CDC PROFESSIONAL SERIES

A STUDY OF SOME ASPECTS OF ASEP DURING ITS FIRST YEAR OF AVAILABILITY

Barry J. Fraser

School of Education
Macquarie University

Jeffrey R. Northfield

Faculty of Education
Monash University

A report of a project funded by the Curriculum Development Centre

CURRICULUM DEVELOPMENT CENTRE
Canberra Australia

3

Published in May 1981 by
The Curriculum Development Centre, Canberra, Australia.
P.O. Box 52, Dickson, A.C.T. 2602

Copyright © Curriculum Development Centre, 1981.

Layout and typesetting by Green Apple Graphics, Canberra

Fraser, Barry J.
A study of some aspects of ASEP during its first year of availability.

ISBN 0 642 96073 9

1. Australian Science Education Project. I. Northfield, Jeffrey R. II. Australia. Curriculum Development Centre. III. Title. (Series : CDC professional series).

507'.1294

FOREWORD

The CDC has taken over responsibility for maintaining the Australian Science Education Project which, from 1969 to 1974, developed materials for a new approach to science in grades seven to ten of secondary schools. ASEP was the first program of curriculum materials development by States carried out on an Australia-wide basis. It was supported in full by funds made available by the Australian and all State Departments of Education.

ASEP materials were first introduced within schools in late 1974 and, by the beginning of 1976, were being widely used. They have since become a major resource for secondary science teachers.

A considerable number of studies, some supported by the CDC, have been made of the impact on and utilisation by schools of ASEP. These include *The Impact of the Australian Science Education Project in Schools,* a study carried out for the Australian Council of Educational Research by Mr John Owen, and a *Review of Research on the Australian Science Education Project* by Dr Barry Fraser.

The volume now published was prepared by Dr Barry Fraser and Mr Jeff Northfield. It reports a study, carried out at Monash University under the overall direction of Professor Peter Fensham, of the impact of ASEP and the problems it has posed for evaluators and of the particular approaches adopted by the writers in meeting these problems. The study investigates:

- the impact of ASEP on science teachers
- the effectiveness of ASEP in promoting pupil learning
- the learning environment as a focus for evaluating ASEP
- learning environment variables

Thus the report is of interest both for the information it provides on the impact of ASEP on Australian schools and for its

consideration of methodological issues in evaluation during the dissemination phase of a major national project.

The CDC is pleased to make this report available as part of its continuing responsibility for ASEP and as a contribution to curriculum evaluation studies.

MALCOLM SKILBECK

DIRECTOR

CONTENTS

	Page
PREFACE	(ix)
CHAPTER 1 BACKGROUND	1
Contemporary Science Education	2
Evaluation of ASEP — Problems and Guidelines	5
Summary	6
CHAPTER 2 IMPACT OF ASEP ON THE SCIENCE TEACHER	11
Design of the Study	12
The Grade 7 Science Teacher Survey	14
Relationships Between Teachers' Attributes and Adoption of ASEP	16
How Teachers saw ASEP and Form 1 Science	20
Impact of ASEP on Science Teachers	25
Summary	28
CHAPTER 3 EFFECTIVENESS IN PROMOTING PUPIL LEARNING	33
Theoretical Considerations	33
Selection and Validation of Measures of Learning Outcomes	36
Design of the Study	41
Results	42
Problems in Interpreting Findings	46
Summary and Conclusions	47
CHAPTER 4 THE LEARNING ENVIRONMENT AS A FOCUS FOR ASEP EVALUATION	53
The ASEP View of the Teacher's Role	53
Curriculum Evaluation and the Learning Environment of the Classroom	54
Effect of Different Teacher Roles on the Classroom Learning Environment	57
Concluding Comments	62

CHAPTER 5 FURTHER RESEARCH 67
Comparison of the Classroom Climate Perceptions of ASEP and Non-ASEP Pupils 67
Relationships between Learning Outcomes and Classroom Climate Perceptions 70
Summary 72

APPENDIX I 73
APPENDIX II 77
APPENDIX III 79

PREFACE

The introduction of ASEP has provided new challenges and problems for evaluation of the program. This report attempts to outline the problems and describe our approaches to dealing with the challenges that ASEP posed for evaluators. In this report these approaches to evaluation have tended to be emphasised more than the actual results obtained. Further details about the results can be found in articles published by the authors (See References). The analysis of some of the information is continuing and further publications will complete the picture that emerges from this study.

The authors are happy to provide further details of the study to people interested in these areas of ASEP evaluation.

To conduct a study of the type described in this report requires the encouragement and support of many people and organisations. In our case we are indebted to the following:

- The CDC for having the confidence in our proposal
- Peter Fensham for his willing support and sponsorship throughout the study
- The many staff of the education faculty at Monash University who provided assistance in many aspects of the project with a special mention to Lindsay Mackay
- Elaine Scott, a very patient typist
- Mr T.J. Ford, Director of Secondary Education in the Victorian Education Department who willingly granted approval to approach the teachers involved in the study
- Finally, the Grade 7 science teachers who not only volunteered to take part in various aspects of the study but in many cases displayed an enthusiasm and interest far exceeding our expectations. We hope that this report is to some extent worthy of the teacher support we received.

Barry Fraser Jeff Northfield

1

BACKGROUND

During 1974, materials developed by the Australian Science Education Project (ASEP) first became available in final published form. The publication of these materials must be considered an important event in the history of Australian education since ASEP was the first national curriculum project in any subject area in this country.

As well as being Australia's first national curriculum venture, ASEP has provided a stimulus and a focus for numerous and varied research endeavours.[1] In particular, a number of studies have involved the important task of evaluating the effectiveness of ASEP materials. The evaluation of ASEP, however, has presented a challenge to the educational researcher because differences between ASEP and conventional materials have rendered some of the standard research methods inappropriate.

The purpose of this report is to describe research into four aspects of the evaluation of ASEP. These four aspects, which are presented in later chapters, are:

- the impact of ASEP on science teachers;
- the effectiveness of ASEP in promoting pupil learning;
- the learning environment as a focus for evaluating ASEP;
- further research involving learning environment variables.

Areas discussed in this chapter include the contemporary scene in science education and the nature of ASEP materials and philosophy.

CONTEMPORARY SCIENCE EDUCATION

The last two decades have seen changes and developments in science education which have been described as 'revolutionary'.[2] This increased activity has involved the establishment of a large number of *curriculum projects*[3] and several commentators[4] have found it useful to distinguish between *first generation* and *second generation* projects.

Some important changes in philosophy have been claimed for second generation projects in recent years when compared to first generation projects. The next section will look at some of these distinctions.

First and Second Generation Curriculum Projects

Many writers have argued that the launching of Sputnik 1 by the Russians in 1957 gave major impetus to a science curriculum reform movement in the United States.[5] The years immediately following the launching saw the appearance of the first national curriculum projects, such as PSSC and BSCS. These projects, and others like them had two common features which stemmed from a central concern for improved scientific manpower. First, it was thought important to concentrate on reforming and *updating content* in each scientific discipline taught in school.[6] Second, this desire to update science content led to the *enlistment of professional scientists* in the development of curriculum materials.[7] In fact, in 1963, there were ten Nobel Laureates actively involved in school science projects compared to none in the previous twenty-five years.[8]

The enlistment of professional scientists in first generation projects was successful in producing accurate and up to date materials but there were a number of important shortcomings

which led to a change in philosophy for the second generation projects. The shift in emphasis is marked by the rationale and philosophy underlying Harvard Project Physics.[9] Other examples of second generation science curriculum projects are Intermediate Science Curriculum Study (ISCS) for use in the junior high school, and Elementary School Science (ESS) for use in the primary or elementary school.[10]

An important feature of first generation projects was their reliance on up to date content from scientific disciplines. However they neglected two other important features which were recognised in second generation projects; first, the *integration of disciplines,* emphasising connections between different scientific disciplines and going beyond traditional scientific disciplines to anthropology, psychology, etc.[11]; second, the emphasis on *humanistic aspects* of science including social, historical, cultural and ethical considerations.[12] Another feature of first generation projects was the attempt to make curriculum materials 'teacher-proof'. That is, there was a belief that the best way to convey science to students was via curriculum packages which could be passed down from developer to student by way of the teacher, but without the imprint of the teacher's ideas, style or personality. In contrast, second generation project materials attempted to provide a degree of *teacher choice.*[13] First generation projects also tended to neglect the pupil as an important determinant of the nature of curriculum materials. In second generation projects, however, the importance of the pupil was acknowledged in two ways. First, they recognised *individual differences* in pupil abilities and interest, and provided for a certain degree of pupil choice.[14] Second, while first generation projects seemed to assume that materials based on the content of science would automatically prove interesting to students,[15] second generation projects were deliberately designed to *promote pupil interest* in science.[16] In fact, one second generation project, namely Harvard Project Physics, has the stated aim of fostering sufficient interest in physics to reverse trends of declining physics enrolments at the senior high school level.[17] Although the above discussion has applied particularly to projects developed in the

United States, numerous important national science curriculum projects (e.g. Nuffield) emerged in the United Kingdom during the same period. Unlike the American or British scene, however, Australia has no history of national curriculum projects. ASEP was the first national curriculum project to be developed in Australia. Its origins, philosophy and materials, and in particular, its relationship to second generation projects, will now be examined.

The Australian Science Education Project (ASEP)

The Junior Secondary Science Project (JSSP), the fore-runner, of ASEP, was set up in 1966 jointly by the Science Standing Committee of the Victorian Universities and Schools Examination Board and the Australian Council for Educational Research. Following favourable reports from teachers using JSSP materials during 1966-68, an approach was made to the Federal Government for funds to instigate a more comprehensive science curriculum project. Between October 1969 and March 1974, $1.2 million was made available, with $750,000 provided by the Federal Government and the remainder provided by all six Australian States. Work on JSSP was terminated and attention turned to a new project, named the Australian Science Education Project, which aimed to produce materials suitable for Grade 7-10 science teaching in all States.[18]

Teachers, officials from the departments of education in each State, scientists, and science educators from colleges and universities attended a guidelines conference in January 1970.[19] These guidelines provided the starting point from which the aims and philosophy of ASEP evolved. Between the time of the conference and early 1974, ASEP produced a total of forty-one units for student use, each occupying approximately a month's teaching time, as well as six service booklets and audio-visual materials. Prototypes of most units were written in a first trial form which was tried out in Victoria, and then in a second trial form which was tried out nationally.[20] ASEP placed emphasis on integration of disciplines, humanistic aspects of science, teacher

choice, pupil individual differences and pupil interest in science. An attempt has been made to integrate traditional science disciplines and social science disciplines within ASEP units, using the environment as an integrating theme.[21] ASEP directs some attention to humanistic aspects of science by stressing the influence of science on human welfare and on aesthetic and ecological aspects of the environment,[22] and by acknowledging the importance of the history of science.[23] The organisation of ASEP materials into a large number of units which are relatively independent of each other allows teachers to choose which units to use, if any, and in what sequence. Units are structured according to Piagetian levels of development, particular attention is paid to readability of materials, students can choose between options within each unit and each pupil can proceed through materials at his or her own rate.[24] Fostering pupil interest in science is a stated aim of ASEP,[25] and was a criterion in selecting the topics for inclusion in ASEP units.[26] Therefore, ASEP possesses, to a reasonable degree, all five characteristics of second generation curriculum projects.

EVALUATION OF ASEP — PROBLEMS AND GUIDELINES

The field of curriculum evaluation is a relatively new one. In fact, Popham[27] has identified the 1967 essays of Stake and Scriven as the real starting point of the curriculum evaluation field. Since then, the rate of publication of articles on curriculum evaluation has increased dramatically.[28]

A feature of recent theoretical writings on curriculum evaluation is the large variety of methodologies and criteria which have been suggested for evaluating curricular effectiveness. This can be seen in the evaluation models proposed by Metfessel and Michael,[29] Sanders and Cunningham,[30] and Fraser.[31] Alternative approaches to the evaluation of a curriculum could involve the collection of opinions of teachers using the curriculum, measurement of pupil attainment, content analysis of curriculum

materials themselves, or the study of the learning environment in classrooms using the curriculum. A curriculum evaluator must therefore decide on the scope of the study and the criteria to judge curriculum effectiveness.

This report looks at four aspects of ASEP. Each of these four studies was carried out during 1974 — the first year ASEP materials were available. They were conducted at the seventh grade level and involved pupils in Victorian high schools.[32] A single request was sent to a number of schools early in 1974 asking for co-operation in a series of studies called the Monash University Science Evaluation Project (MUSEP). The first study, reported in Chapter 2, set out to evaluate the impact of ASEP on science teachers. Mackay[33] has contended that the classroom teacher is an important potential source of information for use in curriculum evaluation, and a number of studies related to ASEP have involved surveys of teacher opinions.[34] A questionnaire investigated teachers' understanding of ASEP philosophy and the impact of ASEP materials on teachers' ideas about science teaching.

The second study (Chapter 3) looked at the effectiveness of ASEP in promoting pupil learning. A battery of learning outcome measures was administered to ASEP and non-ASEP pupils at the beginning and end of the school year to find out the effectiveness of ASEP and non-ASEP materials in promoting learning changes during the year.[35]

The impact of the learning environment as a focus for curriculum evaluation and research related to the learning environment in ASEP classrooms was investigated in the third study (Chapter 4). The fourth study (Chapter 5) made a comparison between the classroom climate perceptions of ASEP and non-ASEP pupils and also looked at the relationship between those perceptions and pupil learning.

SUMMARY

This chapter has discussed the background of the present research. The contemporary scene in science education was

described and first and second generation curriculum projects were distinguished. The origin and nature of ASEP was considered and it was noted that ASEP's philosophy and materials were consistent with the orientations of second generation projects. The evaluation of ASEP was discussed and a brief overview was given of the four studies into the evaluation of ASEP described in the present report.

REFERENCES

1. M. Sieffert, 'A Bibliography of ASEP', *The Australian Science Teachers' Journal* 22, 3, 1976, pp. 51-55.
2. L.S. Shulman & P. Tamir, 'Research on Teaching in the Natural Sciences', in R.M.W. Travers (ed.), *Second Handbook of Research on Teaching*, Rand McNally, Chicago, 1973, pp. 1089.
3. See Reviews: J.D. Lockard (ed.), *Seventh Report of the International Clearinghouse on Science and Mathematics Curricular Developments, 1970.* (A joint project of the A.A.A.S. and the Science Teaching Center, University of Maryland, 1970); and G.A. Ramsay, 'Curriculum Development in Secondary School Science', Parts 1 and 2, *Quarterly Review of Australian Education* 5, 1 and 2, 1972.
4. For example: C. Dede & J. Hardin, 'Reforms, Revisions, Re-examinations: Secondary Science Education Since World War II', *Science Education* 57, 1973, pp. 485-91; and U. Zoller & F.G. Watson, 'Teacher Training for the "Second Generation" of Science Curricula: The Curriculum-proof Teacher', *Science Education* 58, 1974, pp. 93-103.
5. For instance: C.W. Gatewood & E.S. Obourn, 'Improving Science Education in the United States', *Journal of Research in Science Teaching* 1, 1963, pp. 355-99; and P.W. Musgrave, 'Introduction: The Contemporary Situation of Curriculum Theory and Development', in P.W. Musgrave (ed.), *Contemporary Studies in the Curriculum*, Angus and Robertson, Sydney, 1974.
6. L.M. Bennett, 'The Present Plight of Junior High School Science', *Science Education* 49, 1965, pp. 468-76; and P. de H. Hurd, 'The New Curriculum Movement in Science', *The Science Teacher* 29, 2, 1962, pp. 6-9.
7. R.B. Smith, 'An Approach to Measurement in the "New" Science Curriculum', *Science Education* 53, 1969, pp. 411-5; and J.W. Butzow Jr & L.W. Linz, 'A Model for Determining the Objectives of Science Education', *Science Education* 57, 1973, pp. 15-8.

8. C.W. Gatewood & E.S. Osbourn, *Journal of Research in Science Teaching* 1.
9. F.J. Rutherford, 'Flexibility and Variety in Physics', *The Physics Teacher* 5, 5, 1967, pp. 215-24.
10. P. de H. Hurd & J.J. Gallagher, *New Directions in Elementary Science Teaching,* Wadsworth, California, 1968.
11. P. de H. Hurd, *New Directions in Teaching Secondary School Science,* Rand McNally, Chicago, 1969; and C. Dede & J. Hardin, *Science Education* 57.
12. G.A. Ramsay, *Quarterly Review of Australian Education* 5.
13. C. Dede & J. Hardin, *Science Education* 57; and U. Zoller & F.G. Watson, *Science Education* 58.
14. P. de H. Hurd, *New Directions in Teaching Secondary School Science;* and K.D. Lee Dow, *Teaching Science in Australian Schools,* University Press, Melbourne, 1971.
15. P. de H. Hurd, *New Directions in Teaching Secondary School Science,* pp. 97.
16. U. Zoller & F. G. Watson, *Science Education* 58.
17. W.W. Welch & H.J. Walberg, 'Are the Attitudes of Teachers Related to Declining Percentage Enrolments in Physics?' *Science Education* 51, 1967, pp. 436-42.
18. G.A. Ramsay & L.G. Dale, 'The Australian Science Education Project: Its Rationale', *The Australian Science Teachers' Journal* 17, 3, 1971, pp. 51-7; and A.M. Lucas, 'ASEP — a National Curriculum Project in Australia', *Science Education* 56, 1972, pp. 443-51.
19. ASEP, *Report of the Guidelines Conference,* ASEP, Melbourne, 1970.
20. G.A. Ramsey, 'Formative Evaluation and the Australian Science Education Project', *Research 1971,* 1971, pp. 99-108.
21. G.A. Ramsey, *Quarterly Review of Australian Education* 5.
22. ASEP, 'Document 35: The Aims of the Australian Science Education Project', (unpublished manuscript, ASEP, 1970).
23. ASEP, *A Guide to ASEP,* Unit 401, Government Printer, Melbourne, 1974, p. 94.
24. ASEP, *A Guide to ASEP.* Unit 401, Government Printer, Melbourne, 1974.

25. ASEP, 'Document 35: The Aims of the Australian Science Education Project', (unpublished manuscript, ASEP, 1970).
26. ASEP, *A Guide to ASEP,* Unit 401, Government Printer, Melbourne, 1974, p. 95.
27. W.J. Popham, *Educational Evaluation,* Prentice-Hall, New Jersey, 1975, p. 3.
28. See the collection of articles in P.A. Taylor & D.M. Cowley (eds.), *Readings in Curriculum Evaluation,* Brown, Dubuque, 1972; and D.A. Payne (ed.), *Curriculum Evaluation: Commentaries on Purpose, Process, Product,* Heath, Lexington, 1974.
29. N.S. Metfessel & W.B. Michael, 'A Paradigm Involving Multiple Criterion Measures for the Evaluation of Effectiveness of School Programs', *Educational and Psychological Measurement* 27, 1967, pp. 931-43.
30. J.R. Sanders & D.J. Cunningham, 'A Structure for Formative Evaluation in Product Development', *Review of Educational Research* 43, 1973, pp. 217-36.
31. B.J. Fraser, 'Curriculum Evaluation — Help or Hindrance to Teaching and Innovation?', *The Australian Science Teachers' Journal* 21, 1975, pp. 45-51.
32. In Victoria seventh grade is the first year of six years of secondary school.
33. L.D. Mackay, 'Evaluating Curricula: PSSC Physics — A Case Study', in P.W. Musgrave (ed.), *Contemporary Studies in the Curriculum,* Angus and Robertson, Sydney, 1974.
34. For example: D.L. Fisher & B.J. Fraser, 'Teacher Opinion after Using ASEP in Tasmania', *The Australian Science Teachers Journal* 20, 1, 1974, pp. 89-96; and J.R. Northfield, 'Changing Perspectives of Science Teacher Education That May be Associated with Curriculum Development', *Research in Science Education* 5, 1975, pp. 23-32; and J.R. Northfield, 'Some General Problems in Using ASEP Materials', *Lab Talk* 19, 1, 1975, pp. 12-13.
35. B.J. Fraser, 'Are ASEP pupils achieving the aims of science education?' *The Australian Science Teachers' Journal* 22, 3, 1976, pp. 25-33.

2

IMPACT OF ASEP ON THE SCIENCE TEACHER

> As part of its program for the development of its materials ASEP developed a model teacher education program. ASEP recognised the teacher as the key to the learning environment. ASEP materials can be used in a variety of learning situations, but the project saw the roles of teachers using the materials as different from those of teachers in conventional classrooms'.[1]

The project developers clearly recognised the importance of the teacher in their curriculum development program although the teacher education effort was later limited by finance and became an area of concern in the ultimate diffusion and implementation of the ASEP materials.[2]

The first study concentrated on the impact of ASEP on the science teacher for a number of reasons. First, ASEP stressed the importance of the teacher throughout its existence and this is reflected in its publication directed to the science teacher.[3] The final materials could not be regarded as 'teacher-proof'[4] yet teachers were asked to consider a certain philosophy of science

education,[5] a unique approach to organising the content[6] and teaching approaches which departed from the normal approaches to science in schools.[7] The trend for teachers to make important curriculum decisions[8] now became important with the introduction of a wide variety of units each with several options. Second, a number of curriculum adoption and implementation studies have described the way teachers 'translate' curriculum materials into their classrooms and the associated problems.[9] The theories which have developed to assist in understanding these problems[10] and the appropriate teacher education[11] are based on a deep understanding of the teacher in the context of the curriculum.

Thirdly, curriculum evaluation information from teachers is based on actual experience.[12] Teachers alone can respond to the types of information they received prior to the introduction of a curriculum and the deficiencies of the curriculum as it is operating in a classroom.[13] Hurd[14] provides a description of a study of the effects of BSCS materials on biological education. He distinguishes between an impact study and a curriculum evaluation study although both types of study overlap in many respects. Many of the questions Hurd asks in his study can be answered only by gathering data from teachers.

To sum up, teachers provide an important source of evaluation data because of the nature of the ASEP curriculum and their actual experience of the diffusion and implementation of the curriculum. It should also be noted that many of the 'alternative' approaches to evaluation referred to by Stenhouse[15] involve gathering information in a variety of ways from a variety of sources (including teachers).

DESIGN OF THE STUDY

In February, 1974, a questionnaire was sent to Grade 7 science teachers at Victorian co-educational State high schools. The questionnaire was directed to the principal of each school with a request that it be passed on to the appropriate teachers. More than two hundred schools were contacted in this way and by the

end of March replies had been received from 151 teachers in 121 schools. In October 1974 the initial respondents were asked to complete a second questionnaire and by mid-November 108 replies had been received. The following table sets out the information being sought from the science teachers and Appendix 1 presents the responses obtained.

INFORMATION SOUGHT FROM THE TWO QUESTIONNAIRES TO GRADE 7 SCIENCE TEACHERS

Information	First Questionnaire Feb-March 1974	Second Questionnaire Oct-Nov 1974
BACKGROUND INFORMATION		
School, Name, Teaching Experience, Qualifications	✓	–
Estimate of knowledge of ASEP	✓	–
Sources of Information about ASEP	✓	–
FORM 1 SCIENCE 1974		
Science as single subject or integrated with other subjects.	✓	–
Curriculum materials used in 1974	–	✓
Anticipated use of ASEP materials	✓	–
Method of making curriculum decisions	✓	–
Present ideas about Form 1 Science	✓	✓
Present knowledge of ASEP	✓	✓
Information about new curricula	✓	–
Opinions about ASEP materials	✓	✓
Opinions about Form 1 science teaching	✓	✓
Detailed use of ASEP materials in 1974 (inc. way the unit was used and evaluation of unit)	–	✓
Problem areas associated with use of ASEP	–	✓

THE GRADE 7 SCIENCE TEACHER SURVEY

The two questionnaires were designed to monitor the way in which ASEP materials were accepted and used by one group of Victorian science teachers. Some of the results have been made available in two journal articles[16] and this section of the report will describe some of the more important results.

Experience of Grade 7 Science Teachers

The following table sets out the experience of the teachers in the group responding to the first questionnaire.

TEACHING EXPERIENCE OF INITIAL RESPONDENTS

Years of Teaching	First year	1-3 years	4-6 years	7-10 years	More than 10 years
Per cent of sample (N=151)	17	34	19	18	13

One in six of these Grade 7 teachers was a first year teacher and 51 per cent of the respondents had less than four years teaching experience. Up to 83 per cent of them could have had in-service teacher education and up to 51 per cent would have been likely to have done a pre-service course during the ASEP development.

Anticipated Use of ASEP in the First Year

Before the materials were generally available, 79 per cent of the respondents were confident that they had at least sufficient knowledge to consider and use ASEP materials.[17] The majority of schools in this sample[18] treated science as a separate subject in

1974 despite a trend to integrate subjects in the junior years of secondary schools.[19] Approximately seventy per cent of the teachers intended to use at least one unit of ASEP in the first year[20] and in the majority of cases Grade 7 science curriculum decisions had been made by the group of science staff.[21]

The Extent to Which ASEP Materials Were Used During 1974

By the end of 1974, ASEP materials had been used by seventy per cent of respondents to the second questionnaire,[22] although not without some problems.[23]

Information gathered from the 108 respondents to the second questionnaire allowed the teachers to be placed into three groups according to the use made of ASEP materials in 1974.

Group 1 — Intensive users:

Twenty-six teachers who had used more than two units of ASEP and ASEP mateials had been used for more than one term (fourteen weeks).

Group 2 — Moderate users:

Twenty-nine teachers who had used ASEP materials to a lesser extent than Group 1.

Group 3 — Non users:

Thirty-three teachers who had made no use of ASEP materials during 1974.

The remaining thirty teachers were excluded from the analysis because they had volunteered for another part of the research which required teachers to use ASEP or alternative materials, but not both during the year.[24]

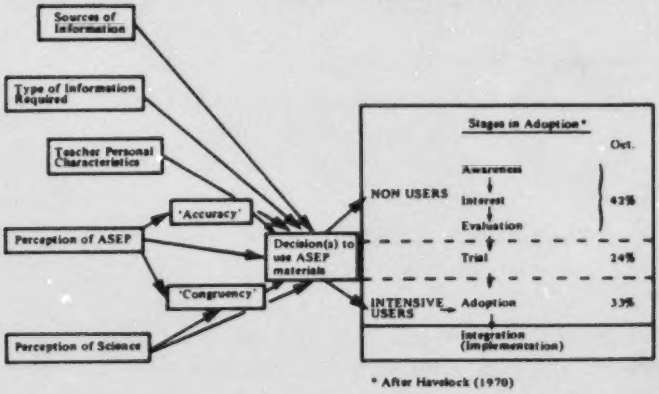
RELATIONSHIPS BETWEEN TEACHERS' ATTRIBUTES AND ADOPTION OF ASEP

There needs to be a certain amount of caution in the interpretation of the relationship between the attributes of the teachers and the adoption of ASEP materials. Intensive use or non use of ASEP materials could be associated with many factors which may or may not be variables included in the study.

Determining Relationships Between Initial Attributes and Final Use of ASEP

The diagram below illustrates the initial attributes of the teachers which were examined to identify variables associated with the use of ASEP materials. The literature associated with the adoption of new curricula[25] had presented each of these attributes as significant factors.

VARIABLES ASSOCIATED WITH USE OF ASEP MATERIALS



* After Havelock (1970)

SOURCES OF INFORMATION ABOUT ASEP
(February — March, 1974)

Source	% Receiving information in this way	For teachers receiving information in this way % very useful	Impact value* (Rank)	Mean score for those receiving information in this way† (Rank)	t value intensive users (IU) vs non users (NU)‡
Journal Articles	77	17	0.13(4)	2.1(6)	2.34*(IU)
ASEP Units (Trial form)	84	51	0.43(1)	2.5(3)	1.05
Teacher Education Materials	57	26	0.15(3)	2.1(4)	1.40
Newsletters	60	15	0.09(9)	2.0(7)	2.70*(IU)
Newspapers	42	2	0.01(10)	1.3(10)	1.55
In-service Courses	50	66	0.33(2)	2.6(2)	0.41
Trials Teacher	14	86	0.12(6)	2.9(1)	1.59
Informal Discussion within the School	70	13	0.09(8)	1.8(9)	1.69
Informal discussion outside the School	56	16	0.10(7)	1.9(8)	2.09‡(IU)
Pre-service Courses	39	33	0.13(5)	2.1(5)	0.68

- Impact value. An attempt to compare the various sources of information by taking into account extent of dissemination (Column 1) and effectiveness (Column 2). (Proportion receiving information x proportion very useful — 'Impact value'.)

† Score based on 3 — very useful to 0 — no use.

‡ Test for difference between means of independent samples. (Intensive users vs non-users). p0.05. Intensive users rated the source as more useful in each case.

p< .05 Intensive users rated the source as more useful in each case.

Sources of Information About ASEP

Earlier it was noted that 79 per cent of the respondents to the first questionnaire said they knew at least enough about the ASEP materials to consider and use them in their classrooms. How did teachers obtain this information about ASEP?

The above table sets out the answer to this as obtained through the questionnaire.[26]

It is worth noting that:

- The number of science teachers who had seen ASEP trial materials was surprising, as the ASEP project produced limited quantities of trial materials. When extent of dissemination (column 1) and usefulness (column 2) are taken into account this source of information appears to have had the most impact (column 3) with these teachers.
- Fifty per cent of teachers had been involved in some form of in-service course (earlier, a figure of 83 per cent of the respondents was suggested as being the maximum target population for this type of activity).
- Thirty-nine per cent of teachers had received information at a pre-service level although up to 51 per cent of teachers could have been involved in a pre-service course while the ASEP development was occurring.
- ASEP units appear to have had most overall impact as a source of information, with in-service courses the next most important source of information (column 3).
- Participation as a trials teacher proved to be very useful for those teachers involved, with in-service courses and the ASEP units also rated as useful to very useful overall (column 4).
- In column 5 the ratings of subsequent intensive users and non-users are compared. For all sources of information except 'pre-service courses' intensive users rated the source of information more highly than non-users. This may indicate that teachers who were thinking of using the materials were more carefully examining all possible sources of information. In three cases the differences in ratings of usefulness reached statistical significance. The teachers who subsequently made intensive use of the ASEP materials rated journal articles, newsletters and discussion outside the school as more useful sources of information than non-users.

Types of Information Required by Teachers

Two descriptions of case studies related to the introduction of new curricula (Gross *et al*[27] and Tom[28]) draw attention to the practical concerns teachers have when they consider using new materials. Clearly, teacher education should be concerned more with practical problems than is often the case. The introduction of ASEP materials at the beginning of the 1974 school year gave an opportunity to see what types of information were most important for teachers. Fourteen statements were written to represent some of the possible types of information which could be provided for teachers in teacher education associated with ASEP introduction. They could be grouped into four general areas:

- Aims and philosophy of the program.
- Practical issues of a general nature — issues that would be likely to be associated with the introduction of any new curriculum.
- Practical issues specific to the ASEP materials.
- Opinions and information resulting from use of the materials.

In the next table, the fourteen statements are set out in the four groupings stated above. Teachers were asked to respond to each statement by responding on a scale from extremely important (scored 3) to no importance (scored 0). The mean value and rank are set out for the total group of respondents and the groups of teachers who subsequently became intensive users and non-users. The following points appear to be worth considering:

- For the total group, the first six statements ranked by teachers include the three statements related to the aims and philosophy of ASEP and also suggest that interest response of pupils and likely organisational problems and costs are regarded as important.

- The practical issues specific to ASEP were not rated very highly overall, yet it is worth noting that the intensive users are tending to rate these as more important (difference between means significant at five per cent level in the case of two of the statements). Two reports[29] discuss several of the practical problems associated with ASEP use which were largely unanticipated before it was introduced.[30]
- There is a tendency for non-users to rate the practical issues of a general nature as more important when compared with intensive users. The concern for methods of assessing pupil achievement was rated significantly higher by later non-users as compared to later intensive users.

Teachers' Opinions of ASEP and Form 1 Science

In both the first and last questionnaires teachers were asked their opinions of ASEP and Form 1 science. The initial opinions of the intensive users and non-users of ASEP are set out below. A test for difference between means of independent samples was used to determine whether there were significant differences between the two groups of teachers before the materials were available.

The intensive users of ASEP seemed to regard the materials as 'more formal', 'clearer', and 'better' than the non-user group of teachers. Intensive users also tended to regard Form 1 science as 'more interesting', 'more pleasant', 'more important' and 'clearer' than non-users. The different views of Form 1 science appear to be just as important a distinguishing feature between the two groups as the views held about ASEP materials.

HOW TEACHERS SAW ASEP AND FORM 1 SCIENCE

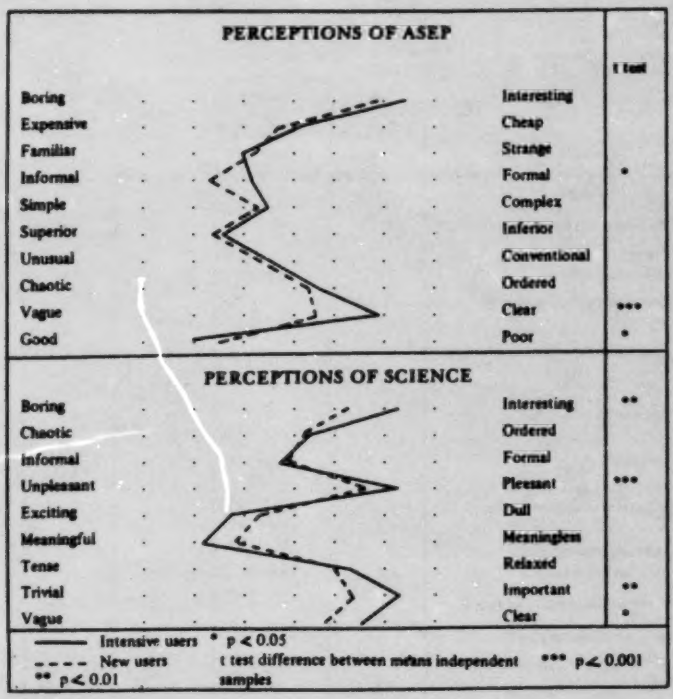
Herron[31] describes a theoretical model to explain why teachers may or may not adopt a new curriculum. He regards the

TYPE OF INFORMATION REQUIRED BY TEACHERS

Type of Information	Total Group Mean† (Rank) (N=151)	Intensive Users Mean† (Rank) (N=151)	Non-Users Mean† (Rank) (N=33)	t test difference between means
Aims, Philosophy Of The Program				
Rationale and philosophy of ASEP	2.22(5)	2.58(2½)	2.03(7½)	**
Theory of learning on which the course is based	2.14(6)	2.58(2½)	2.03(7½)	**
Aims and objectives of the materials	2.41(1)	2.73(1)	2.44(1)	
Practical Issues – General Nature				
Costs of materials and equipment	2.26(4)	2.38(4)	2.42(2)	
Knowledge of new subject matter	1.71(11)	1.68(12)	1.88(9)	
Likely planning and organisational problems	2.28(3)	2.19(6)	2.28(3½)	
Methods of assessing pupil achievement after using the materials	1.80(10)	1.77(11)	2.09(5)	*
Methods of determining the initial ability of pupils	1.62(13)	1.50(14)	1.75(11)	
Practical Issues (Related to ASEP)				
Ways of integrating ASEP with other subjects	1.85(8)	2.08(7)	1.67(12½)	*
Ways of organising group work	1.70(12)	1.88(10)	1.34(14)	*
The teaching role being suggested	1.79(9)	1.96(9)	1.78(10)	
Opinions and Information from Users				
Test results of pupils using trial materials	1.44(14)	1.54(13)	1.59(12½)	
Opinions of teachers who have used materials	1.96(7)	2.00(8)	2.06(6)	
Interest response of pupils who have used the materials	2.29(2)	2.27(5)	2.28(3½)	

* P < 0.05
** P < 0.01

† Score based on range from no importance = 0 to extremely important = 3.



teacher's view of the subject and the teacher's view of the new curriculum as very important variables. Herron's paper develops the concept of *congruence* (the extent to which the views of the subject and the new curriculum correspond). The congruence and *accuracy* of the views then form the basis of Herron's model. Twenty statements were devised to represent some of the features of science education related to the ASEP approach to find out the views of the teachers. They were asked to reply to each of the twenty statements, each preceded by the introduction — 'A Form 1 science course should . . .' and were then asked to reply to the same twenty statements preceded by the introduction — 'At Form 1 level ASEP materials are designed to . . .'.[32]

The responses of the 151 teachers to the first questionnaire were factor analysed and two factors were found to account for 65 per cent of the variance in both the analysis of the view of ASEP and the view of Form 1 science.

Factor 1: Ten statements were found to emphasise this factor when the replies to both statements were analysed.[33] It showed an emphasis on *classroom organisation* involving the pupil, and was described as a *classroom organisation dimension* of ASEP and/or Form 1 science. The replies to each of the ten statements were added (scored 2, 1 or 0) the higher score representing the *pupil centred view* of each teacher with respect to ASEP or Form 1 science.

Factor 2: Five statements emphasising this factor in both statements were analysed. It represented the degree of curriculum structure required[34] and was described as a *curriculum materials organisation dimension* of ASEP and/or Form 1 science. The scoring for the five statements was completed as for Factor 1 (above), the higher score representing a need for structuring the content of the ASEP program or Form 1 science.

An estimate of *congruence* was obtained by comparing the response made to each statement for Form 1 science with the response made to the corresponding statement for ASEP. An exact correspondence was scored 1 and lack of correspondence between responses 0. The *accuracy* of the teacher's perceptions of ASEP was estimated by comparing each teacher's response with the response agreed upon by ten 'experts' each with a sound knowledge of the ASEP development and materials. For eleven out of the twenty statements ninety per cent of the 'experts' had shown agreement with a response. The accuracy score for each teacher was calculated as the number of statements on which there was agreement with the 'experts'.

The table on page 24 sets out some preliminary results of the analysis of teachers' perceptions of ASEP and Form 1 science for intensive users and non-users of the materials. From this table it

can be seen that intensive users differed from non-users in the first year in that they tended to have:

- a more 'pupil centred' view of ASEP materials and Form 1 science;
- a greater degree of congruence between views of Form 1 science and views of ASEP;
- a more accurate view of ASEP when views were compared with the views of people very familiar with the ASEP development. The two groups of teachers did not differ in the way curriculum materials should be organised.

TEACHER PERCEPTIONS OF ASEP AND FORM 1 SCIENCE

	Intensive Users N=26	Non-Users N=33	t value
Classroom Organisation Dimension (Range possible 0-20 High score = increased pupil centred view)			
View of ASEP	18.62	16.70	3.35**
View of Science	18.08	15.61	3.45**
Curriculum Materials Organisation Dimension (Range possible 0-10. High score = increased structure			
View of ASEP	5.69	5.85	0.28 NS
View of Science	6.38	6.36	0.03 NS
Congruence of ASEP and Form 1 Science Views (Range possible 0-15)	9.62	6.85	3.20**
Accuracy of ASEP view (Range possible 0-11)	9.92	8.28	3.19**

† t test for difference between means of independent samples.
** $p < 0.01$

Concluding Comments

An attempt has been made to describe science teachers before ASEP introduction. A number of variables have been isolated. They are sources of information, types of information required, opinions about ASEP and Form 1 science, and views about ASEP and Form 1 science and accuracy and congruency of these views.

These areas are important when considering the teacher education program that should be associated with curriculum development.

IMPACT OF ASEP ON SCIENCE TEACHERS

The data from the second questionnaire provided information about teachers' views on aspects of Form 1 science and ASEP after one year of ASEP availability. The non-user group can be used as a comparison group for the teachers who have made intensive use of the ASEP materials.

Effect of Using ASEP Materials on Science Teachers' Views About ASEP

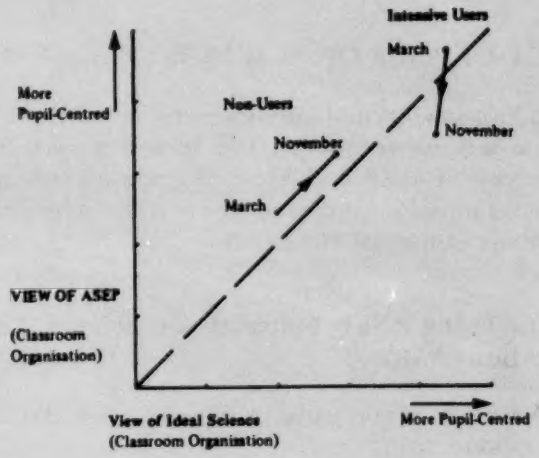
The following four comparisons between intensive users and non-users were made:

- Change in view of science — classroom organisation dimension.
- Change in view of science — curriculum structure dimension.
- Change in view of ASEP — classroom organisation dimension.
- Change in view of ASEP — curriculum structure dimension.

In the third of the preceding comparisons the impact on intensive users was shown to differ significantly from the impact

on non-users. Ten out of the twenty-six intensive users were now adopting a less pupil-centred view of the ASEP materials with a shift of at least one standard deviation. Only five out of thirty-three non-users had shown such a shift ($X^2 = 4.20$, 1df, $p < 0.05$).

CHANGES IN TEACHERS' PERCEPTIONS OF ASEP AND FORM 1 SCIENCE DURING FIRST YEAR OF ASEP AVAILABILITY



The diagram above illustrates this finding. Both intensive users and non-users tend to view ASEP as more 'pupil-centred' than Form 1 science although they differ significantly in their views of ASEP and Form 1 science. (See the table on Teacher Perceptions of ASEP and Form 1 Science, p.24). For intensive users, using ASEP leads to an overall decrease in their view of it as a 'pupil centred' approach. It is interesting to note that it is the view of the ASEP materials that has altered rather than any overall change in the intensive users' view of science.

Effect of Using ASEP Materials on Science Teachers' Response to Semantic Differential Items

The change in responses for intensive users and non-users was compared for each of the ten semantic differential scales relating to ASEP materials and each of the nine semantic differential scales relating to Form 1 science teaching. The change in response of each intensive user and non-user was set out in a distribution table as shown in the next table for Form 1 science (meaningful — meaningless). The Kolmogorov-Smirnov two sample one tailed test[35] was used to test the theory that using ASEP materials leads to science being seen as more meaningful.

The results of a similar analysis of each of the nineteen pairs resulted in the following significant changes in intensive users as compared to non-users.

Intensive users tended to change so that ASEP was viewed as *more superior, more unusual* and *vaguer* when compared with non-users ($p < 0.05$ in each case).

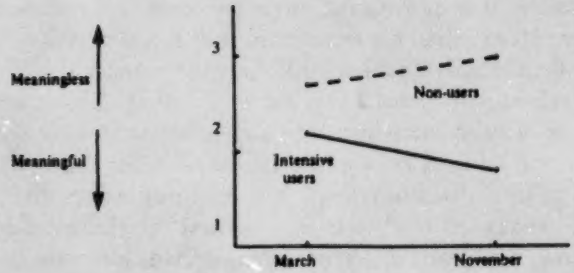
The change in view of Form 1 science (meaningful-meaningless) set out in the table below is illustrated in the graph on page 28.

EXAMPLE OF KOLMOGOROV-SMIRNOV ANALYSIS OF CHANGES DISTRIBUTION FOR MEANINGFUL-MEANINGLESS OF FORM 1 SCIENCE

Form 1 Science	MEANINGFUL ◄——► MEANINGLESS				
'Shift' of	>1 point	1 point	0	1 point	> 1 point
Intensive users	2	6	16	1	0
Non-users	3	7	9	7	7

Pc.05

CHANGE IN VIEW OF SCIENCE (MEANINGFUL-MEANINGLESS)



SUMMARY

The importance of the teacher as a source of data for curriculum evaluation has been argued. A procedure was outlined for gathering data from science teachers in the first year of ASEP availability. A selection of data was presented which described science teachers' initial attributes in terms of subsequent use made of the ASEP materials. In the final section of the chapter the effect of using ASEP materials on some attributes of science teachers was outlined.

The chapter began by describing the teacher as the key to the way in which a new curriculum such as ASEP is used in classrooms. An important justification for looking at the teacher in the first year of this curriculum introduction is that a better understanding of the teacher will lead to more effective teacher education associated with future curriculum development. The results set out in this chapter suggest implications for teacher education. These have not been fully developed but we consider this chapter as a type of evaluation of the teacher education program associated with ASEP, and a source of information to support effective teacher education programs in future curriculum developments.

REFERENCES

1. ASEP, *A Guide to ASEP,* Unit 401, Victorian Government Printer, Melbourne, 1974, p. 109.
2. J.R. Northfield, 'Reflections on ASEP', *The Australian Science Teachers' Journal* 22, 3, 1976, pp. 5-14.
3. ASEP, *A Guide to ASEP,* Unit 401.
4. U. Zoller & F.G. Watson, 'Teacher Training for the "Second Generation" of Science Curricula: The Curriculum-proof Teacher', *Science Education* 58, 1974, pp. 93-103.
5. ASEP, *A Guide to ASEP,* pp. 81-100.
6. ASEP, *A Guide to ASEP,* pp. 59-71.
7. ASEP, *A Guide to ASEP,* pp. 35-51, 72-80.
8. G.W. Beeson & R.F. Gunstone, 'The Teacher's Role in Curriculum Decisions', *The Australian Science Teachers' Journal* 21, 1, 1975, pp. 5-19.
9. For example: N. Gross, J.B. Giacquinta, & M. Bernstein, *Implementing Organisational Innovations: A Sociological Analysis of Planned Educational Change,* Basic Books, New York, 1971; and W.A. Reid & D.F. Walker (eds), *Case Studies in Curriculum Change,* Routledge and Kegan Paul, London, 1975.
10. R.G. Havelock, *A Guide to Innovation in Education,* Institute for Social Research, the University of Michigan, Ann Arbor, Michigan, 1970; and M. Fullan, "Overview of the Innovative Process and the User", *Interchange* 3 (2 and 3), 1972, pp. 1-46.
11. U. Zoller & F.G. Watson, *Science Education* 58; and A. Tom, 'Teacher Reaction to a Systematic Approach to Curriculum Implementation', *Curriculum Theory Network* 11, 1973, pp. 86-93.
12. L.D. Mackay, 'Evaluating Curricula: PSSC physics — a Case Study', in P.W. Musgrave (ed.), *Contemporary Studies in the Curriculum,* Angus and Robertson, Sydney, 1974, pp. 223.
13. P. Armstrong, 'Using ASEP in Your School's Science Classes', *Lab Talk* 18, 4, 1974, pp. 2-6.
14. P. de H. Hurd, 'An Exploratory Study of the Impact of B.S.C.S. Secondary Schools Curriculum Materials', *The American Biology Teacher,* February 1976, pp. 79-85.

15. L. Stenhouse, *An Introduction to Curriculum Research and Development*, Heinemann, London, 1975, pp. 109.
16. J.R. Northfield, 'Changing Perspectives of Science Teacher Education that May be Associated with Curriculum Development', *Research in Science Education* 5, 1975, pp. 23-32; 'Some General Problems in Using ASEP Materials', *Lab Talk* 19, 1, 1975, pp. 12-13.
17. Appendix I A (iv).
18. Ninety per cent. See Appendix I B (i).
19. Victorian Secondary Teachers' Association, 'Secondary Curriculum: Reprints from *The Secondary Teacher*', Victorian Secondary Teachers' Association, 1975.
20. Appendix I B (ii) and (iii).
21. 62 per cent — see Appendix I B (iv).
22. Appendix I B — (ii).
23. Appendix I G; and J.R. Northfield, 'Some General Problems in Using ASEP Materials', *Lab Talk* 19, 1, pp. 12-13.
24. See Chapter 3.
25. M. Herron, 'On Teacher Perception and Curricular Innovation', *Curriculum Theory Network* 7, 1, 1971, pp. 47-52; and A. Tom, *Curriculum Theory Network* 11.
26. Appendix I. Question A (v).
27. N. Gross, J.B. Giacquinta & M. Bernstein, *Implementing Organisational Innovations: A Sociological Analysis of Planned Educational Change.*
28. P. Armstrong, *Lab Talk* 18; and J. Northfield, *Lab Talk* 19.
29. A. Tom, *Curriculum Theory Network* 11.
30. Also see Appendix I G.
31. M. Herron, *Curriculum Theory Network* 7.
32. Details of the twenty statements and teacher responses are set out in Appendix I, Parts C and D.
33. Marked * in Appendix I C.
34. Marked ** in Appendix I C.
35. S. Siegel, *Nonparametric Statistics for the Behavioural Sciences*, McGraw-Hill, Tokyo, 1956, p. 131.

3

EFFECTIVENESS IN PROMOTING PUPIL LEARNING

There is a multitude of criteria and approaches which might be used in curriculum evaluation. One approach which has received particular emphasis from educational researchers is the evaluation of a curriculum in terms of its effectiveness in promoting pupil learning. The main purpose of this chapter is to find out what pupils gained from ASEP materials during a year's science teaching.

THEORETICAL CONSIDERATIONS

Three theoretical issues need to be considered in the design of the study. They are the choice between comparative and non comparative evaluation, problems in identifying goals as a basis for a fair comparison between alternative curricula, and the role of aptitude-treatment interactions in curriculum evaluation research. A major aim is to describe some of the problems encountered, and solutions proposed, in attempting to evaluate ASEP in terms of pupil attainment of aims.

Comparative or Non-Comparative Evaluation

A curriculum evaluation issue on which agreement has not been reached in the literature concerns the choice between comparative and non-comparative evaluation.[1] Cronbach[2] says that a curriculum should be evaluated against one's ideal rather than against competitors. Welch,[3] however, has pointed out that the decision-maker needs to know, not only if a curriculum achieves its goals, but also if it achieves them more effectively than other alternatives. Furthermore, McKeachie[4] has reminded us that a control group is useful in ensuring that extraneous variables (such as the mere passage of time or taking the same test twice) do not account for the changes.

Despite its desirability, comparative curriculum evaluation is not always possible as sometimes 'no alternative programs that could serve as the objects of comparison are available'.[5] One example of this was the adoption of PSSC physics in Victoria when a central decision was made that all classes in the State would abruptly abandon conventional physics courses and begin the PSSC course.[6] But the adoption of ASEP materials was not laid down by a central authority so that, at the time of this research, some schools were using ASEP materials while others used a variety of non-ASEP materials.

It was therefore possible to use a comparison group in the present evaluation of ASEP. A comparative evaluation would provide data useful to the decision-maker concerned with choosing between ASEP and alternative materials already in use, and would provide control over several extraneous variables. This though does not leave out the possibility of also evaluating ASEP against an ideal. Rather, in the present study, data about changes in ASEP pupils over time would provide a basis for a non-comparative evaluation while data on the changes in ASEP pupils relative to non-ASEP pupils would provide a basis for a comparative evaluation.

Choosing Goals for Fair Comparative Evaluation

Grobman[7] noted that, because new and old curricula often have very different goals, the same evaluation standards may not be equally fair to the two competing curricula. This is a problem to be considered in evaluating ASEP, as ASEP materials are quite different from conventional materials in many ways and, even in a non-comparative evaluation, a similar problem would arise because choices available between and within ASEP units enable different ASEP pupils to cover quite different material.

Therefore, an important distinction needs to be made between *content* and *content-free* goals.[8] Content goals of a science course include the mastery of specific terms, concepts, laws and theories covered in that course. On the other hand, content-free goals go beyond the actual subject matter taught and include such things as intellectual skills, attitudes and interests, and understandings of the nature of science. This means that content-free goals which are often common to science courses covering widely different subject matter can provide a fair basis for comparing the achievement of pupils following different curricula.

Content-free goals play another important role in curriculum evaluation as long-term content-free outcomes which build up over longer periods are more important educationally than the short-term content goals.[9] Therefore, it was decided that content-free evaluation standards would be used in this project.

Aptitude-Treatment Interactions

Curricular materials are not likely to have the same degree of effectiveness for all pupils, due to their different aptitudes (such as age, sex, socio-economic status, intelligence, attitudes, personality). In fact, a whole area of research, known as aptitude-treatment interaction research, has grown up in an attempt to isolate pupil aptitudes which are differentially related to achievement under different curricular treatments.[10]

In this study, socio-economic status (SES), IQ and sex were chosen as aptitude variables because evidence in the literature[11] has consistently shown that they are all related to learning outcomes. SES was measured using Congalton's[12] classification of fathers' occupations and IQ was measured with a modified version of the Otis test.[13]

SELECTION AND VALIDATION OF MEASURES OF LEARNING OUTCOMES

Klopfer has made the assertion:

> Research findings can never be more reliable than the data on which they are based, and the findings obtained in an evaluative study must always be interpreted in relation to the quality of the instruments used to obtain the data.[14]

For these reasons, the selection of methods to measure learning outcomes in the present research was considered of paramount importance, and certain criteria described below were used in selecting, modifying and validating the tests. It proved impossible to select a battery of existing tests and it was necessary to modify existing ones and develop new tests.

Seventeen Evaluation Scales Chosen

The next table lists the seventeen evaluation scales chosen for the present study together with a source reference for each scale. The first nine scales measure various inquiry skills, the next three measure aspects of understanding science and the remaining five scales measure various attitude aims. All seventeen scales are content-free.

The TOES battery of tests consists of multiple-choice items developed specially for this study. Two trial forms were tried out before use in the present research. More detailed information about the development of TOES can be found in Fraser.[15]

THE SEVENTEEN SCALES CHOSEN TO MEASURE LEARNING OUTCOMES

Scale No	Scale	Reference
1- 9	**TEST OF ENQUIRY SKILLS (TOES)**	Fraser[23]
	TOES Part A – Reference Materials	
	1. Skill 1: Library usage	
	2. Skill 2: Index and table of contents	
	TOES Part B – Interpreting and Processing Information	
	3. Skill 3: Scales	
	4. Skill 4: Averages, percentages and proportions	
	5. Skill 5: Charts and tables	
	6. Skill 6: Graphs	
	TOES Part C – Critical Thinking in Science	
	7. Skill 7: Comprehension of science reading	
	8. Skill 8: Design of experimental procedures	
	9. Skill 9: Conclusions and Generalisations	
10-12	**Test on UNDERSTANDING SCIENCE (TOUS)**	Klopfer & Carrier[24] *Carrier et al*[25]
	10. Scale P: Philosophical scale	
	11. Scale H: Historical-social scale	
	12. Scale N: Normality of scientists scale	
13-15	**ATTITUDE QUESTIONNAIRE**	
	13. Attitude S: Social implications of science	Ormerod School[26]
	14. Attitude E: Enjoyment of science lessons	Council Project[27]
	15. Attitude I: Interest in Science	
16	**ATTITUDE TO INQUIRY**	Meyer[28]
17	**SCIENTIFIC ATTITUDES**	Mackay & White[29]

The TOUS scales in Table 1 consist of multiple-choice items based on an existing junior high school version of TOUS[16] and a primary school version of TOUS.[17] The present version has been modified to make it suitable for seventh graders. Also, as the two original forms of TOUS give only a single total score, items were divided among the three conceptually distinct subscales listed in the table opposite. The reasons for choosing these three sub-scales and the methods of validating the sub-scales can be found in Fraser and Fisher.[18] Appendix II contains an example of an item from each of the three sub-scales of TOUS.

The attitude questionnaire consists of items scored on a five-point Likert scale which fall into one of the three scales shown in the table. See Fraser and Wright.[19]

The attitude to inquiry scale is a slightly modified version of the 'Finding out about things' scale appearing in Meyer's test.[20] Items in this test are scored on a scale in which pupils allot 0-4 votes for various activities.[21]

The last test listed in the table, the Scientific Attitudes test, is a modified version of Mackay and White's TOPOSS-Self test.[22] While the original form of the test was developed for Australian Grade 10 students, the present version contains numerous modifications to make it more readable and suitable for seventh graders.

The tests were chosen and modified on the basis of *educational importance, subjective pre-trial* and *statistical post-trial criteria.* Each of these criteria, which have been described in some detail in Fraser,[30] is discussed below.

Educational Importance

Cronbach[31] has advocated that all tests, before being considered valid, should be shown to be educationally worthwhile and that no important class of outcome be omitted.

A literature review was used to identify educationally important aims, in particular those most important for science

education.[32] The seventeen evaluation scales were then chosen to provide a reasonable coverage of these aims. A high congruence was shown to exist between ASEP's stated aims and those stated as important in the literature,[33] and so the present study can be used to evaluate ASEP based on its stated goals and on an ideal set of goals taken from the literature.

Subjective Pre-Trial Criteria

A panel of science education and education measurement experts scrutinised the tests before they were used. Each test was assessed according to a number of subjective criteria such as face validity, potential readability, suitability for Australian children, ease of administration and freedom from clues, ambiguities and other item faults[34] and a number of items were reworded or omitted.

Statistical Post-Trial Criteria

Before being used, all the evaluation tests were given a trial run with seventh graders. The sample sizes varied from one hundred for the scientific attitudes scale to four hundred for the TOES tests. Information from these trials was analysed to give information about three important statistical attributes of each test: *internal consistency; discriminant validity;* and *sensitivity.* These statistics gave indications of the overall effectiveness of scales and enabled faulty items to be identified and removed.

Cronbach[35] says that a test score must have substantial internal consistency so that each item measures the same thing measured by the rest of the test. For the present series of scales, the Cronbach α reliability coefficient has been chosen as the index of internal consistency. The table below shows the number of items contained in each scale together with the value of the α coefficient obtained from the trial administration of each scale. This table indicates that the α coefficients ranged from 0.55 to

0.85 and had a median value of 0.69. The values of the α coefficient were all considered satisfactory for curriculum evaluation tests, especially as the average scale length is only about nine items.

SCALE STATISTICS OF INTERNAL CONSISTENCY

Scale	Number of items	Internal Consistency (Cronbach & Reliability)
TEST OF ENQUIRY SKILLS		
TOES 1	10	0.61
TOES 2	9	0.80
TOES 3	10	0.76
TOES 4	8	0.77
TOES 5	11	0.69
TOES 6	10	0.77
TOES 7	10	0.65
TOES 8	10	0.60
TOES 9	9	0.70
TEST ON UNDERSTANDING SCIENCE		
TOUS P	12	0.55
TOUS H	12	0.61
TOUS N	6	0.60
ATTITUDE QUESTIONNAIRE		
Attitude S	8	0.81
Attitude E	7	0.85
Attitude I	6	0.80
ATTITUDE TO INQUIRY	8	0.67
SCIENTIFIC ATTITUDES	11	0.63

As well as being internally consistent, each scale in a test series should possess discriminant validity.[36] This criterion demands that each scale measures a unique construct not measured by other scales in the tests. The statistic chosen as an index of

discriminant validity for this series was the inter-correlation between scales.[37] An examination of inter-correlations among scales, which is shown in Fraser[38] indicated that all correlations were sufficiently low to satisfy the criterion of discriminant validity and maintain each of the seventeen scales as a separate measure.

The third statistical post-trial criterion — sensitivity — is an index of a test's usefulness in detecting pupil changes. For example, insensitivity of an evaluation test could give rise to a *ceiling effect*[39] which occurs when subjects obtain near the maximum score on a pre-test and it is therefore virtually impossible for such students to improve on the post tests, even if they have in fact improved their level of attainment on the construct underlying the test. The scale statistic chosen as an index of sensitivity for the present tests was the distribution of pupil total scores on each scale[40] which are provided in Fraser.[41] They indicate that, on the whole, scores obtained on each scale covered a large proportion of the available range and that the tests were sensitive enough.

DESIGN OF THE STUDY

In line with the decision to conduct a comparative evaluation both an ASEP and a control group were employed in the present study. The ASEP treatment was defined broadly with the only restriction being that ASEP materials be used exclusively during the time of the study and that the sequencing and timing of ASEP units were left to the discretion of each teacher. The control group could use any science instructional materials, as long as they were not ASEP materials.

The table on page 42 shows that the total sample consisted of 1,158 seventh grade pupils in forty-six different classes, each in a different co-educational high school in the Melbourne metropolitan area. The schools were spread widely through the different geographic and socio-economic areas of Melbourne

and, of the forty classes, twenty comprised the ASEP group while twenty-six were in the control group. The actual unit of statistical analysis used in the study was the class aptitude cell. This sampling involved the division of pupils within each class into eight groups according to their SES, IQ and sex. (That is, the eight groups would be: high SES — high IQ — male, high SES — high IQ — female, . . ., low SES — low IQ — female).

SAMPLE SIZE

Group	Classes	Pupils	Class Aptitude Cells
ASEP	20	512	146
CONTROL	26	646	197
TOTAL	46	1,158	343

The study lasted for a whole school year for two reasons. First, a major criticism of past research in science education has been the short time of investigation.[42] Second, it was thought that pupil changes on content-free learning outcomes would be relatively slow so that a comparatively long time between pre-testing and post-testing would be desirable. The seventeen evaluation scales used in the present research were given as pre-tests during March, 1974 and as post-tests in October.

RESULTS

The data were analysed in two ways to throw light on two different questions. First, data about pupil changes in each learning outcome from pre-test to post-test provided a basis for a non-comparative evaluation of ASEP. Second, a comparison of the changes experienced by ASEP pupils with those experienced by non-ASEP pupils provided a basis for a comparative evaluation.

SIGNIFICANCE TESTS FOR CHANGES DURING THE YEAR FOR THE WHOLE SAMPLE

Scale	Maximum Score	Mean		t
		Pre	Post	
1. TOES 1	10	5.6	6.0	4.2***
2. TOES 2	9	6.0	6.0	0.5
3. TOES 3	10	5.1	5.9	8.2***
4. TOES 4	8	2.5	3.0	6.7***
5. TOES 5	11	6.5	6.8	2.8**
6. TOES 6	10	4.6	5.2	5.5***
7. TOES 7	10	5.9	6.2	4.2***
8. TOES 8	10	5.2	5.5	2.4*
9. TOES 9	9	4.3	4.6	3.1**
10. TOUS P	12	5.3	5.8	5.4***
11. TOUS H	6	6.7	7.1	3.0**
12. TOUS N	6	3.5	4.0	7.8***
13. Attitude S	40	27.3	26.8	−2.3*
14. Attitude E	35	23.2	21.9	−5.5***
15. Attitude I	30	18.0	16.9	−6.6***
16. Attitude to Inquiry	32	22.3	22.6	1.2
17. Scientific Attitudes	11	6.0	6.2	2.6**

*p<.05 **p<.01 ***p<.001

This table shows the pre-test mean and post-test mean of the whole sample for each learning outcome together with the results of t tests for dependent samples for differences between pre-test and post-test performance. This data indicates that differences between pre-test and post-test scores were significant for fifteen of the seventeen scales with the two exceptions being TOES 2 and the Attitude to Inquiry scale. All three scales of the attitude questionnaire (social implications of science, enjoyment of science lessons and interest in science) showed that the significant changes over the year were in fact *declines* in positive attitudes. Similar disturbing findings of deterioration in attitude during the study of other science curricular materials have been reported by Mackay,[43] Welch and Walberg[44] and Choppin.[45]

Relative Changes in ASEP and Non-ASEP Students

The next table shows the relative changes experienced by ASEP and control pupils. It provides values from multiple regression analyses involving a direct comparison between the post-test performance of ASEP and control pupils (while statistically controlling for pre-test and other variables). It also gives comparisons of the performance of pupils of higher and lower SES, of higher and lower IQ, and between boys and girls.

SIGNIFICANT F VALUE FOR EACH LEARNING OUTCOME POST-TEST USING INSTRUCTION (ASEP/NON-ASEP), SES, IQ AND SEX AS PREDICTORS, AND CONTROLLING FOR PRE-TEST AND ELEVEN INTERACTIONS

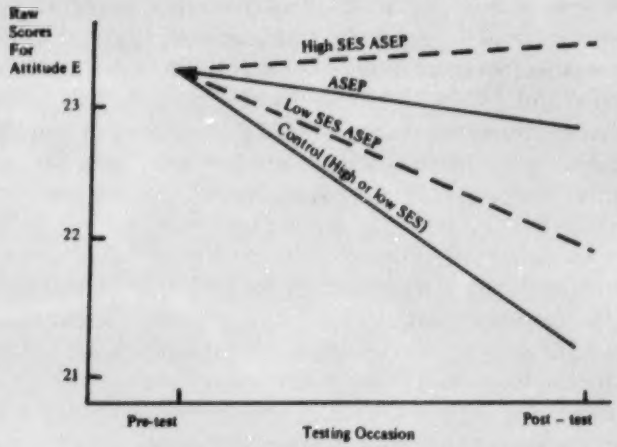
Scale	ASEP/Control	F values SES	IQ	Sex
1. TOES 1			50.0***	
2. TOES 2			30.3***	G 4.3*
3. TOES 3			50.5***	
4. TOES 4			39.4***	B 5.6*
5. TOES 5			57.5***	
6. TOES 6			64.2***	
7. TOES 7			56.5***	
8. TOES 8		3.9*	73.0***	
9. TOES 9			50.1***	
10. TOUS P		5.0*	39.9***	
11. TOUS H			98.7***	
12. TOUS N			32.7***	G 6.9**
13. Attitude S				
14. Attitude E	A 13.7***			
15. Attitude I				
16. Attitude to Inquiry				
17. Scientific Attitudes		4.8*	20.3***	B 7.8**

* $p < .05$, ** $p < .01$, *** $p < .001$

A ASEP superior, G Girls superior, B Boys superior

In all cases for which F values appear for SES or IQ, pupils of higher SES and higher IQ out-performed pupils of lower SES and lower IQ, respectively.

THE SES-TREATMENT INTERACTION



The change in performance of the ASEP group over the year was significantly different from that of the control group for only one of the seventeen learning outcomes, namely attitude *E* (enjoyment of science lessons). The interpretation of this finding is illustrated by the simplified plot of raw scores shown in the diagram above This shows that, while the ASEP and control group experienced similar enjoyment of science lessons at the start of the year, both groups experienced some decline in enjoyment during the year. However, the ASEP group underwent a much smaller decline in enjoyment during the year than the control group. There exists a SES-treatment interaction for Attitude *E*.

The table on page 42 also shows that there were significant relationships between certain learning outcomes and SES, IQ and sex. Pupils of higher SES experienced a greater improvement than pupils of lower SES on TOES 8 (design of experimental procedures), TOUS P (Philosophical scale) and the Scientific Attitudes scale; pupils of higher IQ experienced a greater improvement than pupils of lower IQ on all twelve cognitive tests and on the Scientific Attitudes scale; boys experienced a greater improvement than girls on TOES 4 (Averages, percentages and proportions) and the Scientific Attitudes scale; girls experienced a greater improvement than boys on TOES 2 (Index and table of contents) and TOUS N (Normality of scientists). As well as the significant difference between ASEP and control pupils for Attitude *E* (enjoyment of science lessons), a significant aptitude-treatment interaction also occurred for the Attitude *E* scale. The interpretation of this interaction is also shown in the diagram on page 45. Changes in enjoyment of science lessons during the year in the control group were quite similar for pupils of high and low SES. On the other hand, changes in enjoyment of science lessons in the ASEP group varied markedly with pupil SES. The broken lines in this diagram indicate that, while ASEP pupils of high SES experienced a slight increase in enjoyment of science lessons during the year, ASEP pupils of lower SES experienced a marked decline in enjoyment.

PROBLEMS IN INTERPRETING FINDINGS

The classes in the sample were neither randomly selected nor randomly allocated to experimental and control groups. Nevertheless, it was found that the ASEP group was not significantly different from the control on SES, IQ, sex or any of the seventeen pre-test measures. On the other hand, because some schools and teachers between the teachers in the ASEP and the control group cannot be completely dismissed.

Although the sample was not randomly chosen, it was large, covered wide geographic and socio-economic areas and appeared representative of co-educational high schools in the Melbourne

metropolitan area. Therefore, generalisations to other such schools could be made with reasonable confidence although generalisations to other types of schools or to schools outside Melbourne would be more dangerous.

Despite the importance of content-free goals, it should be appreciated that many important content goals also exist and it must be remembered that content goals do not provide a fair basis for comparisons between competing curricula. An evaluation of ASEP in terms of achievement of content aims would require a different approach,[4] and no inferences about achievement of content goals can be made.

SUMMARY AND CONCLUSIONS

This study is the first major inquiry involving an evaluation of ASEP based primarily on pupil learning outcomes. As such, a certain amount of new ground has necessarily been covered in resolving important conceptual and methodological problems. Therefore, the significance of this study should be seen as much in terms of its methodology as in its actual findings.

An important aspect of the study was the development (or modification) and validation of a series of seventeen evaluation scales suitable for use with Australian seventh graders. In particular, the fact that each of these scales is content-free enables fair comparisons to be made between pupils following quite different curriculum materials.

When the battery of seventeen scales was administered as pre-tests and post-tests to a sample of 1,158 pupils in co-educational high schools in the Melbourne metropolitan area, it was found that the total sample underwent significant changes during the year for fifteen out of seventeen aims considered. The significant changes which occurred for three attitudinal measures, however, were in fact a deterioriation in positive attitude during the year. When the performance of ASEP and control classes was compared using multiple regression analyses, it was found that the two groups differed significantly on only one outcome, namely Attitude *E* (enjoyment of science lessons). While both the

ASEP and the control group experienced a decline in enjoyment of science lessons during the year, the decline in the ASEP group was considerably smaller than in the control group. Furthermore, a significant SES-treatment interaction emerged for the same scale: whereas changes in enjoyment were almost independent of SES in the control group, ASEP pupils of higher SES experienced a small increase in enjoyment while ASEP pupils of lower SES experienced a decline in enjoyment. A significant relationship was also found between SES and changes in three learning outcomes, between IQ and changes in thirteen learning outcomes and between sex and changes in four learning outcomes.

It is of interest to look more closely at the educational significance of the one statistically significant difference in learning outcomes found between ASEP and non-ASEP pupils. It was found that the ASEP group experienced an arrest of 1.7 raw score points (or about one-third of a standard deviation) in the decline in enjoyment of science lessons experienced by the control group. It was also found that the treatment variable accounted for 2.7 per cent of the variance in Attitude *E* post-test scores, after the variance due to pre-test, SES, IQ and sex had been removed. When these data are considered in conjunction with the fact that second generation science projects set out to foster pupil enjoyment of science, the present finding of a significant difference between treatment groups for Attitude *E* assumes educational significance.

REFERENCES

1. L.J. Cronbach, 'Evaluation for Course Improvement', *Teachers College Record* 64, 1963, pp. 672-83; M. Scriven, 'The Methodology of Evaluation', *A.E.R.A. Monograph Series on Curriculum Evaluation 1,* Rand McNally, Chicago, 1967, pp. 39-83.
2. L.J. Cronbach, 'The Psychological Background for Curriculum Experimentation' in P.C. Rosenbloom (ed.), *Modern Viewpoints in the Curriculum,* McGraw-Hill, New York, 1964, p. 24.
3. W.W. Welch, 'Evaluation of the PSNS Course. 1: Design and Implementation', *Journal of Research in Science Teaching* 9, 1972, p. 141.
4. W.J. McKeachie, 'Problems and Perils in Controlled Research in Teaching', in E.R. Steinberg (ed.), *Needed Research in the Teaching of English,* U.S. Office of Education, Washington, 1963, p. 64.
5. A. Lewy, 'The Practice of Curriculum Evaluation', *Curriculum Theory Network* 11, 1973, p. 10.
6. P.J. Fensham & L.D. Mackay, 'The Evaluation of Science Curricula in Centrally Controlled Educational Systems', *IPN-Symposium 1970,* Kiel, 1971.
7. H. Grobman, 'The Place of Evaluation in the Biological Sciences Curriculum Study', *Journal of Educational Measurement* 3, 1966, p. 210.
8. G.A. Forehand, 'The Role of the Evaluator in Curriculum Research', *Journal of Educational Measurement* 3, 1966, p. 201; M.L. Goldberg, 'Evaluation of Innovations', in M.R. Lawler (ed.), *Strategies for Planned Curricular Innovation,* Teachers College Press, Columbia University, New York, 1970.
9. J.M. Atkin, 'Some Evaluation Problems in a Course Content Improvement Project', *Journal of Research in Science Teaching* 1, 1963, p. 131; P. Tamir, 'Long-term Evaluation of BSCS', *American Biology Teacher* 32, 1970, p. 354.
10. L.J. Cronbach, 'The Two Disciplines of Scientific Psychology', *American Psychologist* 12, 1957 pp. 671-84; L.J. Cronbach & R.C. Snow, 'Individual Differences in Learning Ability as a

Function of Instructional Variables', unpublished report, Stanford University, 1969; W.J. Webster & R.L. Mendre, 'The Investigation of Aptitude-Treatment Interactions as an Integral Part of Program Evaluation', *Journal of Experimental Education* 43, 1974, pp. 86-91.

11. D.E. Lavin, *The Prediction of Academic Performance*, Russell Sage Foundation, New York, 1965.
12. A.A. Congalton, *Status and Prestige in Australia*, Cheshire, Melbourne, 1969.
13. L.D. Mackay & B.J. Spicer, 'Educational Turbulance Among Australian Servicemen's Children', *ETASC Project Report* 1, 1975.
14. L.E. Klopfer, 'Evaluation of Science Achievement and Science Test Development in an International Context: The IEA Study in Science', *Science Education* 57, 1973, p. 389.
15. B.J. Fraser, *A Test of Enquiry Skills*, Australian Council for Educational Research, Melbourne, 1979.
16. L.E. Klopfer & E.O. Carrier, 'Test On Understanding Science, Form Jw', unpublished test, Learning Research and Development Center, University of Pittsburgh, 1970.
17. E. Carrier *et al.* 'Test On Understanding Science, Form Ew', unpublished test, University of Illinois, 1966.
18. B.J. Fraser & D.L. Fisher, 'Changes in Pupils During a Year of ASEP in Tasmania', *The Australian Science Teachers' Journal* 20, 2, 1974, pp. 90-100.
19. B.J. Fraser & E.P. Wright, 'Overcoming the Robinson Crusoe Syndrome; A Report of a Small-scale Evaluation of ISCS', *Lab Talk* 19, 2, 1975, pp. 7-8.
20. G.R. Meyer, *A Test of Interests*, Jacaranda Press, Queensland, 1969.
21. Appendix 11.
22. L.D. Mackay & R.T. White, 'Development of an Alternative to Likert Scaling: Tests of Perception of Scientists and Self (TOPOSS)', *Research in Science Education* 4, 1974, pp. 131-9.
23. B.J. Fraser, Curriculum Evaluation. Part 1: Hard or soft, Part II: 'An Illustration Using ASEP Trial Data', *The Australian Science Teachers' Journal* 19, 2, 1973, pp. 35-53.

24. L.E. Klopfer & E.O. Carrier, 'Test On Understanding Science, Form Jw'.
25. E.O. Carrier *et al.*, 'Test on understanding science, Form Ew', unpublished test, University of Illinois, 1966.
26. M.B. Ormerod, 'Social and Subject Factors in Attitudes to Science', *School Science Review* 54, 1973, pp. 645-60.
27. Schools Council Project for Evaluation of Science Teaching Methods. A modified version of the Science Pupil Opinion Poll, unpublished document, University of Leicester, 1973.
28. G.R. Meyer, *A Test of Interests.*
29. *L.D. Mackay & R.T. White, Research in Science Education* 4, 1974.
30. B.J. Fraser, 'Selecting Evaluation Instruments', *Research in Science Education* 4, 1974, pp. 99-111.
31. L.J. Cronbach, 'Test Validation', in R.L. Thorndike (ed.), *Educational Measurement,* 2nd edn, American Council on Education, Washington, 1971.
32. B.J. Fraser, *Research in Science Education* 4.
33. B.J. Fraser, 'Are ASEP's Stated Aims Worth Achieving?', *The Australian Science Teachers' Journal,* 22, 3, 1976, pp. 130-2.
34. Outlined in R.M.W. Travers, *An Introduction to Educational Research,* 3rd edn, Macmillan, New York, 1969.
35. L.J. Cronbach, 'Coefficient Alpha and the Internal Structure of Tests', *Psychometrika* 16, 1951, pp. 297-334.
36. D.T. Campbell & D.W. Fiske, 'Convergent and Discriminant Validation by Multitrait-Multimethod Matrix', *Psychological Bulletin* 56, 1959, pp. 81-105.
37. L.G. Humphreys, 'Individual Differences', *Annual Review of Psychology* 3, 1952, pp. 131-50.
38. B.J. Fraser, *Research in Science Education* 4.
39. P.B. Diederich, 'Pitfalls in the Measurement of Gains in Achievement', in D.A. Payne (ed.), *Curriculum Evaluation: Commentaries on Purpose, Process, Product,* Heath, Lexington, 1974.
40. P.L. Gardner, 'Attitude to Science: A Review', *Studies in Science Education* 2, 1975, pp. 1-41.
41. B.J. Fraser, *Research in Science Education* 4.

42. R.W. Tyler, 'Research in Science Teaching in a Larger Context', *Journal of Research in Science Teaching* 11, 1974, pp. 133-9.
43. L.D. Mackay, 'Changes in Victorian Physics Students During Two Years of Physics Study', *The Australian Physicist* 7, 1970, pp. 103-9.
44. W.W. Welch & H.J. Walberg, 'A National Experiment in Curriculum Evaluation', *American Educational Research Journal* 9, 1972, pp. 373-83.
45. B.H. Choppin, 'The Introduction of New Science Curricula in England and Wales', *Comparative Education Review* 18, 1974, pp. 196-206.
46. B.J. Fraser, *The Australian Science Teachers Journal* 19.

4

THE LEARNING ENVIRONMENT AS A FOCUS FOR ASEP EVALUATION

This chapter begins by outlining the way in which ASEP appeared to describe the teacher's role when using the materials, then describes an appropriate evaluation procedure and its results in twenty-three classrooms using one ASEP unit.

THE ASEP VIEW OF THE TEACHER'S ROLE

ASEP developers produced materials intended to stimulate teachers to re-examine their roles as science teachers and the teacher was required to become the major decision-maker. With the project producing modules (units) of work, and the organisation of units with a certain amount of optional material the teacher was being called on to make curriculum decisions at all levels. Whether good or poor choices were made, the task and responsibility were with the teacher.[1] The teacher was given the opportunity to move away from a role as an 'information

controller' to a role as a facilitator of student learning. The materials were designed to allow students to organise their own activities to a greater extent than other science curricula. The guide for teachers[2] clearly sets out many of the characteristics of the classroom in which the ASEP developers felt the materials would be used most effectively. The environment and organisation of the science classroom was clearly an important focus during the ASEP development.

CURRICULUM EVALUATION AND THE LEARNING ENVIRONMENT OF THE CLASSROOM

Just as the nature of the science classroom has been a focus for the curriculum developer so it can also become a legitimate concern for the curriculum evaluator. Walberg[3] provides some justification for studying classroom variables when he proposes his model for learning in which three groups of variables — aptitude, instructional and environmental variables — are suggested as making major contributions to learning.

Walberg[4] argues that environmental variables can be manipulated by the teacher in contrast to aptitude variables. Such manipulation could be expected to alter learning outcomes.[5] A number of studies have been designed to examine the relationship between environmental variables and learning outcomes and various dimensions of the learning environment have been measured by using pupil self-report inventories such as the Learning Environment Inventory (LEI).

Increasing use is being made of student self-report inventories in studies of classroom learning environments.[6] Anderson and Walberg suggest a number of reasons for this:

- Inventories provide a very economical way of gathering classroom information compared with alternative methods such as classroom observation.
- Inventories provide a more valid way of gaining information about classrooms than methods involving outside

observers. Pupils form a group of respondents likely to be very sensitive to the significant and unique features of a classroom. An outside observer, although trained and systematic, is probably less sensitive than the pupils involved.

In classroom studies the learning environment has been used as both an independent and dependent variable. A number of studies have shown the learning environment (as measured by instruments similar to the LEI) to be a significant predictor of important learning outcomes.[7] Findings like this are critical if there is going to be continuing emphasis on 'shaping' the classroom environment in curriculum development. It is essential that the roles of teachers and pupils being suggested by curricula such as ASEP be shown to be likely to lead to desired pupil outcomes.

It has also been demonstrated that certain characteristics of the class can be used to predict the classroom environment. Studies using learning environment variables as dependent variables are essential.

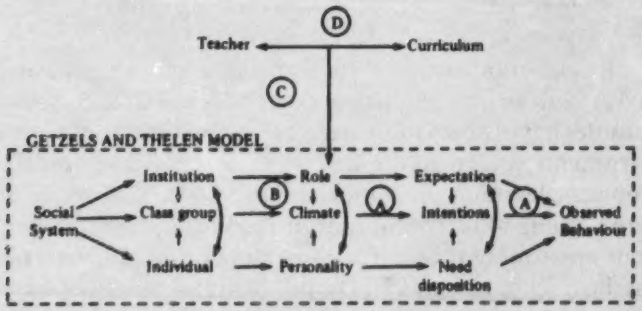
In Walberg's model of learning[8] increasing attention to environmental variables is justified by arguing that this group of variables is subject to manipulation and therefore important in learning. If this is the case we would expect to be able to show that certain characteristics of the class are related to the learning environment.

Teacher educators and curriculum developers have to be concerned with the factors which seem to be associated with particular learning environments.

The relationships between learning environment variables and various predictors on the one hand, and learning outcomes on the other can be illustrated by using the Getzels and Thelen model[9] which forms the theoretical basis for LEI development.

The diagram on page 56 illustrates Getzels and Thelen's concept of climate as being the result of a complex relationship between the roles of the participants in the classroom and the individual personalities of the participants.

RATIONALE FOR LEARNING ENVIRONMENT EMPHASIS IN CURRICULUM DEVELOPMENT AND EVALUATION



Pupils and teachers occupy certain social positions related to the way science is taught in a school. As the roles and personalities of the participants vary so will the classroom climate. Looked at in this way programs such as ASEP which attempt to change the classroom are in fact doing so by asking teachers to re-examine their roles as science teachers. The resource materials allow teachers to move from being major organisers of learning in the classroom to being facilitators of learning by having students work in groups and allowing the written resources to take over some of the organising function for the students.

The remainder of the chapter is concerned with one aspect of the role of teachers and pupils using ASEP materials and the effect on classroom climate, (Relationship *B* in the previous diagram). Before describing this study however, the previous diagram can be used to place this aspect of the study into an overall context. The relationships represented by *A* in the diagram show the classroom climate (learning environment) variables as independent variables in the prediction of learning outcomes. In Chapter 5 of the report, this relationship is described in more detail. *D* represents the impact of ASEP on teachers, the subject of Chapter 2. *C* represents the effect ASEP introduction has had on teacher and student roles in the

classroom. The important teacher education questions of how teachers might be encouraged to consider and adopt new roles would be included in *C* of the previous diagram.

EFFECT OF DIFFERENT TEACHER ROLES ON THE CLASSROOM LEARNING ENVIRONMENT

Design of the Study

Of the 151 respondents to the first questionnaire (see Chapter 2) twenty-three Grade 7 teachers were asked to use the ASEP unit 'Places for People' at the start of Term III, 1974. Each teacher was given:

- a copy of 'A Guide to ASEP';
- a copy of the teachers' guide for the ASEP unit 'Places for People';
- a class set of the student books for 'Places for People';
- a class set of the ASEP service unit 'Heat and Temperature';
- copies of student charts, questionnaires, etc.

At the meeting with each teacher the design of the study was explained (see diagram below). However, no instructions were given as to how the ASEP unit should be presented; this was left to the teacher.

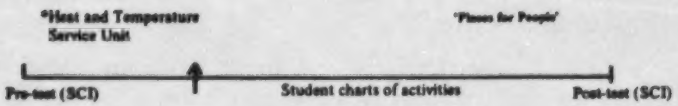
Methods Used in the Study

The SCI is a modification of the LEI. The modifications were designed to make the inventory suitable for Grade 7 students and the final form is the result of preliminary trials. The nine scales included were selected because they seemed to represent important features of ASEP classrooms as described by the ASEP developers.[10] The table on page 56 sets out the nine scales with an example of an item in each scale, the Cronbach α reliability value for each scale and the number of items which make up each scale of the SCI.

DETAILS OF S.C.I. SCALES

Scale (Name of similar LEI Scale)	Sample Item	Cronbach α Reliability	No. of items in Sub-scale
Formality	• Students follow strict rules in science classes. (+)	0.53	5
Individuality	• Students can choose to study different science topics that interest them. (+)	0.551	6
Speededness (Speed)	• The work in science is covered too quickly. (+)	0.72	5
Environmental Suitability (Environment)	• Science lessons are held in a room which allows us to carry out our science activities easily. (+)	0.70	6
Goal Directedness (Goal Direction)	• Students have little idea of what the real point of studying science is. (–)	0.66	6
Satisfaction	• After the class, the students feel science lessons are worthwhile. (+)	0.83	6
Disorganisation	• There are long periods during which some class members do not know what to do. (+)	0.74	6
Difficulty	• The questions asked in science are often difficult. (+)	0.48	6
Competitiveness	• Students often race to see who can finish first. (+)	0.60	5

DESIGN OF THE STUDY



* Teachers were informed that only p. 1-19 of the service unit contained information directly relevant to the unit *Places for People.*

Students were asked to respond by circling one of four alternatives: strongly disagree (SD), disagree (D), agree (A), strongly agree (SA) and these were scored 2, 4, 6 and 8 respectively for a positive item shown (+) in the table, and 8, 6, 4 and 2 for a negative item, shown (—) in the table. No response or multiple responses to an item were scored 5. It was therefore possible to obtain a score for each pupil in each class for each of the scales in the SCI.

The Student Charts

Students were asked to keep a record of their activities in each lesson to show how the ASEP unit was presented in each class. Pupils completed their own charts at the end of each lesson by placing a tick against the part or parts of the unit they had been working on in that lesson. When the charts were returned at the end of the unit it was possible to collate the information from each pupil in the class to form a 'pattern' of the way the unit had been presented in each class. Two examples of these 'patterns' are included in Appendix III. For each lesson it was possible to determine the number of different parts of the unit that had received attention from pupils.[11] The mean number of activities per lesson was then calculated.

The classrooms were grouped according to the mean number of activities per lesson. The next table summarises the way in which the classrooms were grouped and it appears that science teachers were implementing the ASEP unit in three distinct ways:

- **Wide student choice** — in these classrooms students were involved in a wide range of activities from the first lesson onwards.[12]
- **Less student choice** — in these classrooms students were involved in very few activities in the initial lessons in the unit. Towards the end of the unit a wider variety of activities was evident.
- **Limited student choice** — students were involved in very few activities in each lesson throughout the unit.[13]

CLASSROOMS GROUPED ACCORDING TO MEAN NUMBER OF ACTIVITIES PER LESSON WHEN USING THE ASEP UNIT 'PLACES FOR PEOPLE'

Mode of Implementation	Mean No. of Activities Lesson	Range
1. Wide student choice (5 classes)	8.7	7.8 to 9.7
2. Less student choice (5 classes)	7.0	6.8 to 7.3
3. Limited student choice (7 classes)	4.6	2.2 to 5.8

Note: Six classes of the original twenty three classes could not be included in this analysis.

- Two classes did not complete the ASEP unit because of teacher changes.
- Two classes used the ASEP unit in a General Studies program and the activities were linked with other 'non-unit' activities.
- Two classes had small student numbers (< 15) which meant that the mean number of activities per lesson could not be compared with other classes (> 23).

Method of Analysis

In a number of studies using the LEI scales as dependent variables a number of predictors of classroom climate have been reported.[14] Although this study intended to examine the effect of the method of presentation on the ASEP learning environment, it was necessary to also consider other variables that could affect the learning environment. Previous studies show that the learning environment is likely to be affected by curriculum, class size, grade level, girl ratio, socio-economic status and ability level.[15] The study design controlled the first four groups of variables to some extent (a particular ASEP unit used in a Grade 7 co-educational class in Victorian high schools). SES has been shown to be associated with students' response to 'competition' items. No attempt was made to control this variable in this study. Ability level has been measured in several ways in past studies (cognitive pre-test, IQ, grade point average, etc.). Ability level seemed to predict difficulty, disorganisation, speed, formality and goal direction. No design control was attempted but it seemed to be important to check whether ability level was a significant factor in students' perception of the learning environment.

This was attempted by asking teachers to indicate the students who appeared to have most ability in science, and the students who had the most difficulty in science at the end of the unit.

Three factors were considered in analysis of the findings: mode of implementation; ability level; and change in perception of learning environment during the ASEP unit (time effect).

Results and Interpretations

The results of the analysis are set out in the next table and some of the significant results are represented in the following six figures. A summary of the findings is presented below:

- The presentation of the ASEP unit seemed to be associated with significant changes in five of the nine scales making

up the SCI. Over the period of time the ASEP unit 'Places for People' was presented students reported a significant *increase* in *individuality* and *goal directedness*. There was a significant *decrease* in *satisfaction, difficulty* and *competitiveness* (see Time — Factor C in the table and Figs. A, D and F).

- The way ASEP was implemented seemed to be associated with significant differences in student perceptions on five of the nine scales which make up the SCI. Overall wide choice classrooms are seen as more *individualised, less speeded, more satisfying* and *less disorganised* than limited choice classrooms (see Figs. A, B, E and F). The less choice classrooms were perceived as *more goal directed* by these students than students having the unit implemented in other ways. (See Mode of Implementation — Factor A in the table and Fig. D.)
- Ability level proved to be a significant variable for one of the scales of the SCI. *Low ability students* reported the Unit presentation as being *more speeded* than other ability groups. (See Ability Level — Factor B in the table and Fig. B).

In one scale the *F* value of the A x C interaction (Mode of Implementation and Time) reached significance at the five per cent level. Fig. C illustrates this interaction — the classes in which a large number of activities occurred showed a slight increase in environmental suitability while the classes with very few activities per lesson showed a decrease in environmental suitability. The physical conditions appeared less suitable in classrooms where ASEP was used with a more restricted student choice.

CONCLUDING COMMENTS

An argument has been presented for evaluating ASEP by gathering data about the learning environment where ASEP materials are being used. A study was described which attempted

Analysis of Variance Table Summarising the Effects of Mode of Implementation and Ability Level on Student Perceptions of Nine Aspects of Learning Environment During Presentation of ASEP Unit 'Places for People'.

ANOVA SUMMARY — **DEPENDENT VARIABLE**

SOURCE	df	FORMALITY	INDIVID.	SPEED	ENVIR. SUITABILITY	GOAL DIR.	SATISFACTION	DISORG.	DIFFICULTY	COMPETITION
Mode of Implementation A	2.42	2.33 NS	7.27**	5.59**	1.72 NS	3.42*	4.68*	3.68*		
Ability Level B	2.42	1.90 NS		4.81*		2.30 NS			2.01 NS	
Time C	1.42	(+)2.61 NS	(+)17.41**		(−)2.49 NS	(+)5.02*	(−)7.67**		(−)5.83*	(−)16.62**
A x B	4.42		1.27 NS							
A x C	2.42				3.56*	1.50 NS	2.13 NS	2.58(*)		
B x C	2.42			1.74 NS						
A x B x C	4.42			1.55 NS						

Critical F Values for Probability Levels

		(*) 0.10	* 0.05	** 0.01
F_{crit}	2.42	2.43	3.22	5.15
	1.42	2.83	4.07	7.27
	4.42	2.08	2.59	3.80

(+) Represents increase in scale value

(−) Represents decrease in scale value

GRAPHS TO ILLUSTRATE THE SIGNIFICANT EFFECTS FROM THE PRECEDING TABLE

Figure A

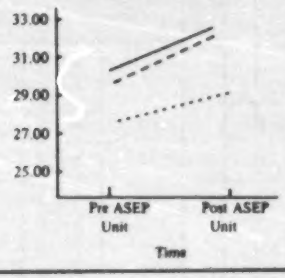


Figure B

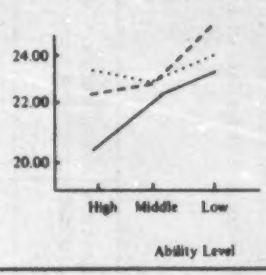


Figure C

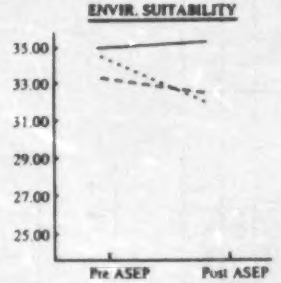


Figure D

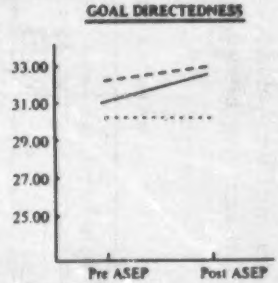


Figure E

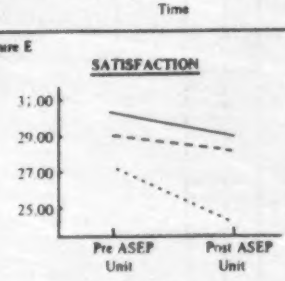
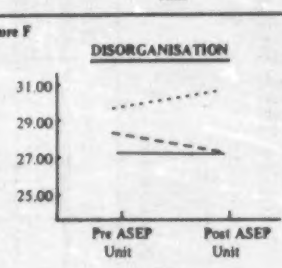


Figure F



Wide student choice ——— Less student choice - - - - Limited student choice .....

to determine the effect of presenting an ASEP unit on student perceptions of the learning environment. Incorporated in this study was an attempt to measure different modes of implementing the ASEP unit related to the different roles of teachers and pupils in selecting the content of the unit. It was possible to determine different student perceptions of the learning environment related to presentation of the unit (Factor *C*), the way in which the unit had been implemented (Factor *A*) and ability level of the students (Factor *B*).

With the introduction of science curricula which suggest appropriate roles for teacher and pupils it seems necessary that the effect of different methods of implementation on the resulting learning environment continue to be investigated. The teacher education associated with ASEP has sought to make teachers aware of appropriate roles for teacher and pupil to occupy when using ASEP materials. Empirical evidence related to the effectiveness of various methods of implementation may be useful in further clarifying the arguments for using curriculum materials in particular ways.

REFERENCES

1. J.R. Northfield, 'Reflections on ASEP', *The Australian Science Teachers' Journal* 22, 3, 1976, pp. 5-14.
2. ASEP, *A Guide to ASEP,* Unit 401, Victorian Government Printer, Melbourne, 1974.
3. H.J. Walberg, 'Models for Optimizing and Individualizing School Learning', *Interchange* 2, 3, 1971, pp. 15-27.
4. H.J. Walberg, *Interchange.*
5. G.J. Anderson & H.J. Walberg, 'Learning Environments', in H.J. Walberg (ed.), *Evaluating Educational Performance: a Source book of Methods, Instruments and Examples,* McCutchan, Berkeley, 1974; B.J. Fraser, 'Classroom Climate as Predictor and Criterion in Science Education Research', *Research in Science Education* 6, 1976, pp. 109-20.
6. B.S. Randhawa & L.L.W. Fu, 'Assessment and Effect of Some Classroom Environment Variables', *Review of Educational Research* 43, 3, 1973, pp. 303-21.
7. G.J. Anderson & H.J. Walberg, *Evaluating Educational Performance: a Sourcebook of Methods, Instruments and Examples.* Cutchan, Berkley, 1974.
8. H.J. Walberg, *Interchange 2.*
9. J.W. Getzels & H.A. Thelen, 'The Dynamics of Instructional Groups', *59th NSSE Yearbook,* University of Chicago, 1960.
10. ASEP, *A Guide of ASEP,* Unit 401.
11. In this determination, an activity was counted when two or more students were recorded as working on that activity.
12. See Appendix III. Example 1.
13. See Appendix III. Example 2.
14. G.J. Anderson & H.J. Walberg, *Evaluating Educational Performance: a Sourcebook of Methods, Instruments and Examples;* H.J. Walberg & A. Ahlgren, 'Predictors of the Social Environment of Learning', *American Educational Research Journal* 7, 2, 1970, pp. 153-67.
15. G.J. Anderson & H.J. Walberg, *Evaluating Educational Performance: a Sourcebook of Methods, Instruments and Examples.*

5

CHAPTER 5
FURTHER RESEARCH

The research outlined in this chapter consists of two aspects. Firstly, a comparison will be made between the classroom climate perceptions of ASEP and non-ASEP pupils. Secondly, the relationship between learning outcomes and classroom climate perceptions will be explored.

COMPARISON OF THE CLASSROOM CLIMATE PERCEPTIONS OF ASEP AND NON-ASEP PUPILS

This research can best be understood by comparing it with the study involving learning outcomes, described in Chapter 3. While the previous study involved the relative changes in learning outcomes experienced by a sample of ASEP and non-ASEP classes during a year, this research involved a comparison of the classroom climate perceptions of ASEP and non-ASEP pupils at the end of second term. Whereas the study in Chapter 3 involved a sample of forty-six classes, this research involved ten ASEP and ten control classes drawn from the original forty-six class sample: this sample is described in more detail in the following table. In both the present and the previous study, each

class was drawn from a different co-educational high school in the Melbourne metropolitan area, and both the ASEP and the control group consisted of schools which were representative of the geographic and socio-economic areas of Melbourne. As in the investigation described in Chapter 3, the present study included the three aptitudinal variables of SES, IQ and sex.

SAMPLE SIZES FOR ANALYSES EMPLOYING CLASSROOM CLIMATE SCALES

Group	SAMPLE SIZE		
	Classes	Pupils	Class aptitude cells
ASEP	10	266	76
Control	10	265	77
Total	20	531	153

Classroom climate was measured in this research using a slightly different version of the science class inventory from that described in the previous chapter. These climate scales were validated with the sample of 531 pupils described in the previous table using the statistical criteria of internal consistency, discriminant validity and sensitivity. The next table lists the nine climate scales involved in the present research together with the number of items in each scale, scale reliability values and the scale intercorrelation matrix.

The techniques to analyse the climate data were analogous to those used for learning outcome data. It will be recalled that multiple regression analyses were employed in comparing the post-test performance of ASEP and non-ASEP pupils, while controlling statistically for the corresponding pre-test, for SES, IQ and sex, and for various interaction terms. Similarly, in the present analyses, scores on each classroom climate scale in August were compared for ASEP and non-ASEP pupils, while controlling statistically for SES, IQ, sex and interactions. The class aptitude cell sampling unit was again employed as the unit of statistical analysis but no pre-test climate data were available.

NUMBER OF ITEMS, RELIABILITY OF, AND INTERCORRELATIONS BETWEEN EACH CLASSROOM CLIMATE SCALE

Scale	No. of Items	Cronbach α Reliability	Scale Intercorrelations								
			Div	Sp	Env	Goal	Sat	Dis	Diff	Comp	Ind
Diversity	4	0.50	1.00	0.00	0.09	-0.05	-0.11	0.05	0.03	0.03	-0.05
Speed	6	0.66		1.00	-0.35	-0.30	-0.31	0.39	0.36	0.27	-0.07
Environment	6	0.63			1.00	0.32	0.26	-0.41	-0.24	-0.23	0.04
Goal Direction	7	0.62				1.00	0.43	-0.42	-0.26	-0.09	0.07
Satisfaction	6	0.80					1.00	-0.48	-0.34	-0.05	0.10
Disorganisation	6	0.66						1.00	0.33	0.29	0.11
Difficulty	5	0.50							1.00	0.23	-0.02
Competitiveness	5	0.53								1.00	0.12
Individualisation	10	0.71									1.00

SIGNIFICANT F VALUES FROM MULTIPLE REGRESSION ANALYSES FOR EACH CLIMATE SCALE AS CRITERION AND TREATMENT (ASEP/CONTROL), SES, IQ AND SEX AS PREDICTORS.

Criterion	F Values			
	ASEP/control	SES	IQ	Sex
Diversity	0.2			
Speed	1.6		L 9.6*	
Environment	A 3.9*			
Goal Direction	0.2			
Satisfaction	A 7.5**			
Disorganisation	0.2			
Difficulty	3.0		L 17.3***	
Competitiveness	2.9		L 7.4**	
Individualisation	A 15.3***		L 8.4**	

*p<.05, **p<.01, ***p<.001

A Higher climate scores associated with ASEP

L Higher climate scores associated with lower IQ

The results of these analyses, which have been described in more detail in Fraser,[1] are displayed in the above table. This indicates that ASEP pupils, relative to control pupils, perceived their classes as being characterised by a significantly better environment, significantly more satisfaction and significantly more individualisation. The table also indicates that pupils of high IQ saw their classes as being characterised by less speed, less difficulty, less competitiveness and less individualisation than pupils of lower IQ in the same classrooms.

In interpreting these findings it should be realised that, because of the absence of pre-test climate data, it is possible that differences between the climate of ASEP and control classrooms at the end of second term could be attributable in part to differences in climate existing at the start of the year. Therefore, some caution should be exercised in interpreting these findings. Despite this caution, the present results are quite consistent with other findings from research related to ASEP. Firstly, it was seen in Chapter 3 that ASEP pupils underwent more favourable changes in their enjoyment of science lessons during a year's science teaching than did control pupils. Secondly, Power and Tisher[2] reported that the significant changes in climate scores experienced by ASEP classes over time were in the favourable direction for the large majority of climate dimensions.

RELATIONSHIP BETWEEN LEARNING OUTCOMES AND CLASSROOM CLIMATE PERCEPTIONS

This section will describe analyses in which climate scales are employed as predictors of learning outcomes. These relationships were explored with the 531 pupils described in this chapter's first table, using scores on the same nine classroom climate scales and post-test scores on the seventeen outcomes employed in Chapter 3.

The next table shows the simple correlation between each classroom climate scale and post-test performance on each of the seventeen learning outcome measures. This table indicates a

SIMPLE CORRELATION OF EACH LEARNING OUTCOME POST-TEST WITH EACH CLASSROOM CLIMATE DIMENSION

	Simple Correlation								
Criterion	Div	Speed	Env	Goal	Satis	Disorg	Diff	Comp	Indiv
TOES 1 (Library)	0.13	-0.15	0.15	-0.11	-0.07	-0.07	-0.28***	-0.17*	-0.12
TOES 2 (Index)	0.25**	-0.08	0.26***	-0.15	-0.03	-0.12	-0.18*	-0.15	-0.16*
TOES 3 (Scales)	0.28***	-0.10	0.13	-0.10	0.01	-0.14	-0.18*	-0.10	-0.20*
TOES 4 (Averages)	0.15	-0.12	-0.01	-0.27***	-0.11	-0.06	-0.17*	-0.01	-0.12
TOES 5 (Charts)	0.18*	-0.19*	0.01	-0.17*	-0.17*	-0.07	-0.27***	-0.18*	-0.19*
TOES 6 (Graphs)	0.21**	-0.06	0.13	-0.14	-0.08	-0.08	-0.24**	-0.22**	-0.23**
TOES 7 (Comp)	0.34***	-0.14	0.07	-0.04	-0.11	-0.11	-0.27***	-0.27***	-0.34***
TOES 8 (Expti)	0.12	-0.03	0.11	0.04	-0.04	-0.17*	-0.15	-0.13	-0.26***
TOES 9 (Concl)	0.27***	-0.13	0.02	-0.09	-0.17*	-0.08	-0.16*	-0.30***	-0.24**
TOUS P (Philos)	0.10	-0.22**	0.06	-0.09	-0.09	-0.13	-0.18*	-0.27***	-0.18*
TOUS H (Hist-soc)	0.12	-0.10	0.08	-0.18*	-0.14	-0.07	-0.24**	-0.16*	-0.28***
TOUS N (Normal)	0.22**	-0.23**	0.13	-0.05	-0.01	-0.04	-0.25**	-0.25**	-0.23**
Att. S (Soc imp)	-0.05	-0.23**	0.26***	0.21**	0.42***	-0.31***	-0.13	-0.10	0.05
Att. E (Enjoy)	0.01	-0.30***	0.32***	0.27***	0.64***	-0.35***	-0.14	0.01	0.25**
Att. I (Interest)	-0.05	-0.08	0.17*	0.32***	0.53***	-0.31***	0.11	0.19*	0.05
Att. to Enquiry	0.08	-0.11	-0.00	0.02	0.10	-0.09	-0.06	0.13	0.01
Scientific Atts.	0.14	-0.04	-0.10	-0.11	-0.02	-0.04	-0.18*	0.02	-0.04
Median Mag. of r	0.14	0.12	0.11	0.11	0.10	0.09	0.18	0.16	0.19

* $p < .05$; ** $p < .01$; *** $p < .001$

- Lower climate scores associated with higher criterion scores

Sample size was 153 class aptitude cells (20 schools)

Critical $r = 0.16$ at .05 level of confidence

reasonably strong relationship overall between classroom climate and learning outcome scores, with the median magnitude of the correlation coefficient over all learning outcomes ranging from 0.09 for Disorganisation to 0.19 for Individualisation. Furthermore, the numb r of correlations significantly greater than zero at the 0.05 level of confidence was sixty-three out of 153, which is about eight times the number expected by chance.

While this table provided information about simple correlations between learning outcomes and classroom climate, multiple regression analyses could be employed to investigate the relationship between classroom climate and changes in learning outcomes over the year, while controlling statistically for SES, IQ and sex. When such multiple regression analyses were carried out, numerous interesting relationships were found between individual climate dimensions and changes in individual learning outcomes. Taken together, the simple correlational analyses and the multiple regression analyses provide strong evidence for the existence of a relationship between classroom climate and learning outcomes.

This finding of a relationship between classroom climate and learning outcomes is similar to the results from a series of studies reviewed by Anderson and Walberg.[5]

SUMMARY

Like the previous chapter, this chapter described research involving one type of learning environment variables, namely classroom climate dimensions. These climate dimensions were employed both as criteria on which to compare ASEP and non-ASEP classes and as predictors of learning outcomes.

When the classroom climate dimensions were employed as dependent variables, it was found that ASEP pupils held more favourable climate perceptions than non-ASEP pupils along the environment, satisfaction and individualisation dimensions.

It was also found that IQ mediated pupil climate perceptions: pupils of higher IQ perceived their classes as less speeded, less difficult, less competitive and less individualised than pupils of lower IQ in the same classrooms. When the classroom climate

variables were employed as independent variables, it was found that the relationship of classroom climate variables to learning outcomes was relatively strong.

The findings from the two sets of analyses employing learning environment variables in this chapter, together with the results of research involving environmental variables from the previous chapter, can be taken to support the general usefulness of learning environment variables in curriculum evaluation research.

REFERENCES

1. B.J. Fraser, 'Classroom Climate as Predictor and Criterion in Science Education Research', *Research in Science Education* 6, 1976, pp 109-20.
2. C.N. Power & R.P. Tisher, 'Variations in the Environment of Self-Paced Science Classrooms: Their Nature, Determinents and Effects', paper presented to the Annual Conference of the Australian Association for Research in Education, Adelaide, November, 1975.
3. G.J. Anderson & H.J. Walberg, 'Learning Environments', in H.J. Walberg (Ed.), *Evaluating Educational Performance: A Sourcebook of Methods, Instruments and Examples,* McCutchan, Berkeley, 1974.

APPENDIX I

RESULTS FROM QUESTIONNAIRE SURVEY OF SCIENCE TEACHERS IN MARCH AND NOVEMBER, 1974

Details of Questionnaire	% response March	% response November
A. Background Information		
(i) to (iii) Details of name, school, teaching experience and qualifications		
(iv) **Present Knowledge of ASEP**		
. Nil or very hazy idea	8	
. A little knowledge but would need to know more to consider using the materials	14	Not Applicable
. Sufficient knowledge to consider and use the materials	69	
. A great deal known about the ASEP approach	10	
(v) **Sources of Information about ASEP**	% useful or very useful	
. Journal articles (e.g. Lab Talk, A.S.T.J. etc.)	68	
. ASEP units	79	
. ASEP teacher education materials	49	
. ASEP newsletters	48	Not Applicable
. Newspaper articles	12	
. Inservice courses	49	
. Participation as an ASEP trials teacher	14	
. Informal discussion among teachers within the schools	50	
. Informal discussion among teachers from other schools	40	
. Pre-service courses (e.g. Dip.Ed)	29	

Details of Questionnaire	% response March		% response November	
B. Form 1 Science in 1974				
(i) Approach to Form 1 Science				
Form 1 Science presented as a separate subject	90		Not Applicable	
Form 1 Science integrated with other subjects (e.g. General Studies)	9			
	Extensive Use	**Limited Use**	**Extensive Use**	**Limited Use**
(ii) Curriculum material intended for use in 1974 at Form 1 level.				
. ASEP materials	18	54	26	44
. J.S.S.P. materials	26	53	35	40
. ' Teacher prepared ' materials	32		41	46
. Discovery in Science	32		7	21
(iii) Likely use of ASEP materials in 1974				
. Not likely to be used	19		See actual use B (ii) above	
. Will obtain one or more units for examination	11			
. Will try at least one unit with class	39			
. Have planned a program using ASEP materials	31			
(iv) Method of making curriculum decisions for 1974				
. Decision made by the teacher concerned	18			
. Decision made by someone in authority (e.g. co-ordinator)	8			
. Decision made by science staff after discussion	62			
. A continuation of the previous Form 1 Science course	9			
. Other (Please Specify)	2			

C. Present Ideas about Form 1 Science D. Present Knowledge of ASEP	March % response				November % response			
	Form 1 Science		ASEP		Form 1 Science		ASEP	
A Form 1 Science course should . . . . At Form 1 level ASEP materials are designed to . .	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree
*1. have pupils spend most of their time working in small groups	61	4	81	0	69	0	88	0
2. cater for a wide range of abilities in pupils (e.g. reading ability)	94	1	74	5	99	0	69	5
3. have the teacher direct most of the activities proceeding in the classroom	25	32	7	62	36	27	8	69
4. include clear instructions (e.g. teacher guides) for teachers and pupils to follow	64	5	79	2	69	4	83	2
5. require the teacher to construct his/her own course from a variety of units and resources	64	4	62	17	63	6	68	14
**6. present ideas from each of the major scientific disciplines (e.g. Chemistry, Physics etc.)	62	9	54	11	56	8	54	9
*7. base learning on student activity and experiment on most occasions	87	3	91	0	90	2	94	0
**8. present content which has been selected to provide a sound preparation for later studies	33	14	28	19	29	25	28	19
*9. present materials which have been selected on the basis of likely pupil interests	74	1	78	1	77	1	72	0
*10. allow pupils the opportunity to select some of their activities during the year	81	3	85	0	82	2	85	2
*11. include the study of current (often controversial) issues (e.g. pollution, drug abuse, etc.	64	7	64	3	59	4	60	3
**12. provide a year's course which forms part of a clearly planned Form 1 to IV program of science	52	13	25	31	53	15	25	34
**13. present content consisting of basic scientific concepts and theories needed by pupils	40	14	37	14	47	10	37	15
**14. allow for frequent testing of pupils to check that they have minimum levels of scientific knowledge	42	16	40	14	43	13	32	27
*15. emphasize reasoning skills (processes of science) rather than scientific knowledge	85	3	78	1	84	0	75	2
*16. encourage pupils to work at their own rates	62	5	85	1	71	6	90	0
*17. Allow the teacher to spend most of the class time with small groups and individuals	77	2	88	0	79	0	88	1
*18. include topics not usually found in science courses (e.g. psychological and sociological topics)	38	18	50	4	44	9	62	4
19. have pupils involved in little or no reading	5	72	7	53	6	64	6	62
*20. allow pupils to perform activities not part of the planned curriculum	67	3	55	6	68	3	53	2

* items which loaded on Factor 1 - *Classroom organization* dimension
** items which loaded on Factor 2 - *Curriculum materials organization* dimension

E **Information about New Curricula**

	Mean scores March	Mean scores November
F Opinions about ASEP materials and Form 1 Science teaching		
Scoring Extremely 1 – Neutral 4 – Extremely 7		
ASEP materials		
Boring ..... Interesting	6.15	5.87
Expensive ..... Cheap	3.56	3.96
Familiar ..... Strange	3.17	3.03
Informal ..... Formal	2.80	2.79
Simple ..... Complex	3.64	3.74
Superior ..... Inferior	2.81	2.85
Unusual ..... Conventional	3.20	3.43
Chaotic ..... Ordered	5.02	4.62
Vague ..... Clear	5.45	5.50
Good ..... Poor	2.02	2.2
Form 1 science teaching		
Boring ..... Interesting	5.93	5.63
Chaotic ..... Ordered	4.75	4.38
Formal ..... Informal	4.35	4.31
Unpleasant ..... Pleasant	5.92	5.63
Exciting ..... Dull	2.91	2.99
Meaningful ..... Meaningless	2.33	2.57
Tense ..... Relaxed	5.35	5.14
Trivial ..... Important	5.94	5.69
Vague ..... Clear	5.25	5.21

		% agreeing November
G Teachers' ratings of some problems in using ASEP materials		
1. There are frequently insufficient basic items of equipment (e.g. test tubes) to perform the unit as intended		23
2. Often items of equipment cannot be obtained when required		38
3. More equipment tends to be lost and broken		35
4. It is difficult to store the equipment needed for each unit		50
5. The teacher's guide provides insufficient help to a teacher in presenting the unit		8
6. It is very difficult to follow the progress of individual pupils through a unit		30
7. Too much time is required in preparation prior to using a unit		16
8. Evaluation of pupils becomes too difficult when different pupils are doing different activities		28
9. Too many pupils have reading difficulties with the ASEP materials		38
10. Pupils become bored using the booklets all the time		53
11. The teacher has to assume a new role which is difficult to adjust to		10
12. The pupils tend to be far more noisy		38
13. Movement around the class is likely to be more difficult to control		36

APPENDIX II

SAMPLE ITEMS FROM SCALES MEASURING LEARNING OUTCOMES

Scale	Scoring Procedure	Sample Item
Tous P	A score of 1 is given to the keyed response, D.	When several new facts are discovered which do not fit a scientific theory, scientists are likely to A throw out the theory since the facts do not fit it B change the facts a little so that they will fit the theory. C ignore the facts and keep the theory as it is D change the theory a little so that all facts will fit it.
Tous H	A score of 1 is given to the keyed response, C.	Scientitist study plants mainly to A help farmers to produce more food. B discover how to make new medicines. C understand how plants live and grow. D find out where plants will grow best.
Tous N	A score of 1 is given to the keyed response, D.	Bill always gets good results in school, likes to build model aeroplanes, and plays jokes on his classmates. Frank gets high results in arithmetic, likes to read books, and plays baseball. Janet is serious and clever, and likes to dance. Who would become a scientist? A Bill only B Frank only C Janet only D Any one of the three
Attitude to Inquiry	Each pupil allots 0-4 votes to each statement according to the extent to which a statement is like what he/she would have said. The item score is the number of votes given to No. 1.	What the surface of the moon is like 1. Robert said he would borrow a telescope and study the moon. 2. Pat said she would rather read a book about the moon. 3. Dick said he would rather ask an astronomer. 4. Mary said she would rather ask her science teacher.
Scientific Attitudes	Each pupil picks which of the pair of statements better describes him/her. A score of 1 given to response it.	A. You show consideration for other people B. You are observant.

APPENDIX III

EXAMPLES OF STUDENT CHARTS SHOWING 'PATTERNS' OF STUDENT ACTIVITY DURING THE ASEP UNIT

CHART 1 WHAT PART OF THE UNIT ARE YOU WORKING ON? NAME: .....

Example 1 Wide student choice

LESSON (Class size 34 Lesson time 50 mins)

PARTS OF THE UNIT				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Shelters	1	Why live in a shelter?	p. 3															
	2.	Shelters from natural materials	p. 4															
	3	Some other shelters	pp. 5 8															
	4.	Building a house	pp. 9 11															
Option 1	BUILDING MATERIALS																	
	1	Making cement mortar	pp. 14 15															
	2	Bricks	pp. 16 18															
	3	Testing metals	p. 19															
	4.	Timber	pp. 20 22															
		Further activities	p. 23															
Option 2	BUILDING MATERIAL RESEARCH																	
	1	Heat	pp. 24 26															
	2	Does thickness make any difference?	pp. 27 28															
	3.	Does colour make any difference?	p. 29															
	4	Light and dark	p. 30															
	5	Sound	pp. 31 33															
Option 3	DESIGN FOR LIVING																	
	1	What do people want in a home?	pp. 34 36															
	2	The daily routine	pp. 36 37															
	3	What sized rooms?	pp. 38 39															
	4	How suitable are furniture and fittings?	p. 40															
Option 4	CHOOSING A PLACE TO LIVE		pp. 41 45															
Option 5	WHY OWN YOUR OWN?		pp. 46 51															
SOME OTHER THINGS YOU MAY LIKE TO DO			pp. 52 53															

Any other activities during the unit (state what you did)

Example 2 Limited student choice				LESSON														(Class size 29 Lesson time 45 mins)
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Shelters	1	Why live in a shelter?	p. 3															
	2	Shelters from natural materials	p. 4															
	3	Some other shelters	pp. 5–8															
	4	Building a house	pp. 9–11															
Option 1	BUILDING MATERIALS																	
	1	Making cement mortar	pp. 14–15															
	2	Bricks	pp. 16–18															
	3	Testing metals	p. 19															
	4	Timber	pp. 20–22															
		Further activities	p. 23															
Option 2	BUILDING MATERIAL RESEARCH																	
	1	Heat	pp. 24–26															
	2	Does thickness make any difference?	pp. 27–28															
	3	Does [illegible] make any difference?	p. 29															
	4	Light and dark	p. 30															
	5	Sound	pp. 31–33															
Option 3	DESIGN FOR LIVING																	
	1	What do people want in a home?	pp. 34–36															
	2	The daily routine	pp. 36–37															
	3	What sized rooms?	pp. 38–39															
	4	How suitable are furniture and fittings?	p. 40															
Option 4	CHOOSING A PLACE TO LIVE		pp. 41–45															
Option 5	WHY OWN YOUR OWN?		pp. 46–51															
SOME OTHER THINGS YOU MAY LIKE TO DO			pp. 52–53															

Any other activities during the unit
(State what you did)